PROCEEDINGS

AND

TRANSACTIONS

OF THE

LIVERPOOL BIOLOGICAL SOCIETY.

VOL. XIX.

SESSION 1904-1905.

LIVERPOOL:

C. Tinling & Co., Ltd., Printers, 53, Victoria Street.

1905.

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PROCEEDINGS

OF THE

LIVERPOOL BIOLOGICAL SOCIETY.

OFFICE-BEARERS AND COUNCIL.

Ex-Presidents:

1886—87 PROF. W. MITCHELL BANKS, M.D., F.R.C.S.
1887—88 J. J. DRYSDALE, M.D.
1888—89 PROF. W. A. HERDMAN, D.Sc., F.R.S.E.
1889—90 PROF. W. A. HERDMAN, D.Sc., F.R.S.E.
1890—91 T. J. MOORE, C.M.Z.S.
1891—92 T. J. MOORE, C.M.Z.S.
1892—93 ALFRED O. WALKER, J.P., F.L.S.
1893—94 JOHN NEWTON, M.R.C.S.
1894—95 PROF. F. GOTCH, M.A., F.R.S.
1895—96 PROF. R. J. HARVEY GIBSON, M.A.
1896—97 HENRY O. FORBES, LL.D., F.Z.S.
1897—98 ISAAC C. THOMPSON, F.L.S., F.R.M.S.
1898—99 PROF. C. S. SHERRINGTON, M.D., F.R.S.
1899—1900 J. WIGLESWORTH, M.D., F.R.C.P.
1900—1901 PROF. PATERSON, M.D., M.R.C.S.
1901—1902 HENRY C. BEASLEY.
1902—1903 R. CATON, M.D., F.R.C.P.
1903—1904 REV. T. S. LEA, M.A.

SESSION XIX., 1904-1905.

President:

ALFRED LEICESTER.

Vice-Presidents:

REV. T. S. LEA, M.A.
PROF. W. A. HERDMAN, D.Sc., F.R.S.

Hon. Treasurer:

T. C. RYLEY.

Hon. Librarian:

JAMES JOHNSTONE, B.Sc.

Hon. Secretary:

JOSEPH A. CLUBB, M.Sc.

Council:

HENRY C. BEASLEY.
PROF. BOYCE.
DR. J. W. ELLIS.
W. J. HALLS.
W. HANNA, M.A., M.B.
W. HAYDON.
W. S. LAVEROCK, M.A., B.Sc.
JOSEPH LOMAS, F.G.S.
PROF. PATERSON, M.D., M.R.C.S.
SIR CHARLES PETRIE.
PROF. SHERRINGTON, F.R.S.
W. C. STAPLEDON.

REPORT of the COUNCIL.

During the Session 1904-1905 there have been seven ordinary meetings and two field meetings of the Society, both joint meetings with the Owens College Biological Society.

The communications made to the Society have been representative of almost all branches of Biology, and the exhibition of microscopic preparations and other objects of interest has been well maintained at the meetings.

By invitation of the Council, Dr. W. E. Hoyle, Director of the Manchester Museum, delivered a lecture on February 10th, on "Recent Researches on the Cephalopoda."

The Library continues to make satisfactory progress, and additional important exchanges have been arranged during the year.

The Treasurer's statement and balance sheet are appended.

The members at present on the roll are as follows:—

Honorary Members	8
Ordinary Members	67
Associate Members	3
Student Members	10
Total	88

SUMMARY of PROCEEDINGS at the MEETINGS.

The first meeting of the nineteenth session was held at the University, on Friday, October 14th, 1904.

The President-elect (Mr. Alfred Leicester) took the chair in the Zoology Theatre.

1. The Report of the Council on the Session 1903-1904 (see "Proceedings," Vol. XVIII., p. viii.) was submitted and adopted.

2. The Treasurer's Balance Sheet for the Session 1903-1904 (see "Proceedings," Vol. XVIII., p. xix.) was submitted and approved.

3. The following Office-bearers and Council for the ensuing Session were elected:—Vice-Presidents, Professor Herdman, D.Sc., F.R.S., and Rev. T. S. Lea, M.A.; Hon. Treasurer, T. C. Ryley; Hon. Librarian, James Johnstone, B.Sc.; Hon. Secretary, Joseph A. Clubb, M.Sc.; Council, Prof. Boyce, H. C. Beasley, Dr. J. W. Ellis, W. J. Halls, W. Hanna, M.A., M.B., W. Haydon, W. S. Laverock, M.A., B.Sc., Joseph Lomas, F.G.S., Prof. Paterson, M.D., M.R.C.S., Sir Charles Petrie, Prof. Sherrington, F.R.S., and H. Wade-Deacon.

4. Mr. Alfred Leicester delivered the Presidential Address entitled, "Mollusca and their Shells" (see "Transactions," p. 1). A vote of thanks was proposed by Mr. W. Haydon, seconded by Prof. Herdman, and carried with acclamation.

The second meeting of the nineteenth session was held at the University, on Friday, November 11th, 1904. The President in the chair.

1. Prof. Herdman, F.R.S., submitted the Annual Report on the work of the Liverpool Marine Biology Committee and the Port Erin Biological Station (see "Transactions," p. 5).
2. Mr. P. M. C. Kermode, F.S.A.Scot., communicated a paper entitled, "Notes on the Pre-historic Antiquities of the Isle of Man" (see "Transactions," p. 57).

The third meeting of the nineteenth session was held at the University, on Friday, December 9th, 1904. The President in the chair

1. Mr. H. C. Beasley exhibited and described casts of a series of footprints from the Trias.
2. The Secretary communicated a note by Mr. Oulton Harrison on the occurrence of the Kingfisher in the neighbourhood, and exhibited a specimen recently taken at Wavertree.
3. Dr. J. H. O'Connell gave a paper on "Young Crocodilians in Captivity" (see "Transactions," p. 165).

On December 12th, by invitation of the Owens College Biological Society, a party of Members went to Manchester, when a lecture was delivered by Prof. Hickson on "Organisms of Disease."

The fourth meeting of the nineteenth session was held at the University, on Friday, January 13th, 1905. The President in the chair.

1. Mr. H. C. Beasley exhibited some canine teeth taken from a portion of a skull, found on the Leasowe shore.
2. Mr. J. A. Clubb communicated a note on the occurrence of variation in the number of spines of the first dorsal fin of *Gobius minutus*.
3. Mr. J. Johnstone submitted the Annual Report of the investigations carried on during 1904, in connection with the Lancashire Sea Fisheries Committee (see "Transactions," p. 181).

The fifth meeting of the nineteenth session was held at the University, on Friday, February 10th, 1905. The President in the chair.

1. Dr. W. E. Hoyle, Director of the Manchester Museum, delivered a lecture on "Recent Researches on the Cephalopoda." The Lecturer gave an interesting account of many points in the minute anatomy of some of the cuttlefishes, and described some remarkable and previously unknown organs discovered in specimens taken by Prof. Herdman off Ceylon. A vote of thanks, proposed by Prof. Herdman and seconded by Mr. Clubb, was unanimously passed.

The sixth meeting of the nineteenth session was held at the University, on Friday, March 17th, 1905. The President in the chair. By invitation of the Council a

representative body of Members of the Owens College Biological Society was present.

1. Prof. Sherrington contributed a paper on "Motor localization in the brain of the Gorilla," in which was contained the result of recent researches on the localization of motor centres.

2. Dr. O'Connell exhibited and described living specimens of the poisonous lizard, *Heloderma*; and Mr. V. H. Sugden exhibited a very fine example of the Ringed Snake.

3. Mr. H. C. Beasley exhibited a series of casts of footprints of recent Reptilia, taken in conjunction with Dr. O'Connell for the purpose of comparison with fossil footprints from the Trias at Storeton and elsewhere.

4. Prof. Herdman briefly described the Pearl producing parasites of the Ceylon Pearl Oyster.

The seventh meeting of the nineteenth session was held at the University, on Friday, May 12th, 1905. The President in the Chair.

1. Mr. H. C. Beasley exhibited casts of various footprints of *Rhyncosaurus* from different localities, made into a single slab of plaster.

2. Dr. O'Connell exhibited and described the habits and points in the structure of a number of living Chelonians.

3. Prof. Moore contributed a paper on researches made at Port Erin on the susceptibility of fertilized Echinoderm eggs to minute doses of chemicals, in stimulating segmentation.

The eighth meeting of the nineteenth session was a Field Meeting, held jointly with the Owens College Biological Society, at Delamere Forest, on Saturday, May 27th.

The ninth meeting of the nineteenth session was the Annual Field Meeting held at Hilbre Island, on Saturday, June 17th. At the short business meeting held after tea, on the motion of Mr. Alfred Leicester from the chair, Mr. Joseph Lomas was unanimously elected President for the ensuing session.

LIST of MEMBERS of the LIVERPOOL BIOLOGICAL SOCIETY.

SESSION 1904-1905.

A. Ordinary Members.

(Life Members are marked with an asterisk.)

ELECTED.

1903 Abram, Dr. J. Hill, 74, Rodney Street.

1888 Beasley, Henry C., Prince Alfred Road, Wavertree.

1903 Booth, jun., Chas., 30, James Street, Liverpool.

1894 Boyce, Prof., University, Liverpool.

1889 Brown, Prof. J. Campbell, 8, Abercromby Square.

1886 Caton, R., M.D., F.R.C.P., 78, Rodney Street.

1886 Clubb, J. A., M.Sc., Hon. Secretary, Free Public Museums, Liverpool.

1900 Cole, F. J., University, Liverpool.

1902 Cowley, R. C., 6, Sandon Terrace, Liverpool.

1903 Dixon-Nuttall, F. R., Ingleholme, Eccleston Park, Prescot.

1903 Deacon, H. Wade, 8, Ullet Road, Liverpool.

1900 Ellis, Dr. J. W., 18, Rodney Street, Liverpool.

1886 Gibson, Prof. R. J. Harvey, M.A., F.L.S., University, Liverpool.

1902 Glynn, Dr. Ernest, 67, Rodney Street.

1903 Graham, Miss M., Ballure House, Great Crosby.

1903 Guthrie, Alex., 3, Fenwick Street, Liverpool.

1886 Halls, W. J., 35, Lord Street.
1901 Hanna, W., M.A., M.B., 25, Park Way, Liverpool.
1896 Haydon, W., 135, Bedford Street S.
1886 Herdman, Prof. W. A., D.Sc., F.R.S., Vice-President, University, Liverpool.
1893 Herdman, Mrs., B.Sc., Croxteth Lodge, Ullet Road, Liverpool.
1897 Holt, Alfred, Crofton, Aigburth.
1902 Holt, A., jun., Crofton, Aigburth.
1903 Holt, George, 5, Fulwood Park, Liverpool.
1903 Holt, Richard D., 1, India Buildings, Liverpool.
1900 Horsley, Dr. Reg., Stonyhurst, Blackburn.
1904 Jenkins, J. T., D.Sc., Ph.D., Fisheries Office, Preston.
1898 Johnstone, James, B.Sc., Hon. Librarian, University, Liverpool.
1903 Jones, Sir Alfred L., African House, Water Street.
1886 Jones, Charles W., Allerton Beeches.
1903 Jones, Dr. Robert, 11, Nelson Street, Liverpool.
1894 Lea, Rev. T. S., M.A., Vice-President, Leek Vicarage, Kirkby Lonsdale.
1886 Leicester, Alfred, President, Scot Dale, New Ferry.
1896 Laverock, W. S., M.A., B.Sc., Free Museums, Liverpool.
1886 Lomas, J., Assoc. N.S.S., F.G.S., 13, Moss Grove, Birkenhead.
1903 Macalister, Dr. Charles, 35, Rodney Street, Liverpool.
1903 Musson, G. T. G., 17, Bertram Road, Liverpool.
1904 Newstead, R., F.Z.S., School of Tropical Medicine, Liverpool.
1888 Newton, John, M.R.C.S., 2, Prince's Gate, W.
1900 Nisbet, Dr., 7, Croxteth Road, Liverpool.
1904 O'Connell, Dr. J. H., 2, Dudley Road, Liverpool.
1904 Pallis, Miss M., Tätoi, Aigburth Drive, Liverpool.

1894 Paterson, Prof., M.D., M.R.C.S., University, Liverpool.
1894 Paul, Prof. F. T., Rodney Street, Liverpool.
1903 Petrie, Sir Charles, 7, Devonshire Road, Liverpool.
1897 Quayle, Alfred, 7, Scarisbrick New Road, Southport.
1903 Rankin, J., 67, South John Street, Liverpool.
1903 Rathbone, H. R., Oakwood, Aigburth.
1903 Rathbone, Herbert R., C.C., 15, Lord Street, Liverpool.
1890 *Rathbone, Miss May, Backwood, Neston.
1897 Robinson, H. C., Holmfield, Aigburth.
1900 Rylands, Ralph, 2, Charlesville, Claughton.
1887 Ryley, Thomas C., Hon. Treasurer, 10, Waverley Road.
1894 Scott, Andrew, Piel, Barrow-in-Furness.
1895 Sherrington, Prof., M.D., F.R.S., University, Liverpool.
1886 Smith, Andrew T., 5, Hargreaves Road, Sefton Park.
1895 Smith, J., F.L.S., The Limes, Latchford, Warrington.
1903 Stapledon, W. C., 2, Marine Park, West Kirby.
1903 Thomas, Dr. H. Wolferstone, School of Tropical Medicine, Liverpool.
1903 Thomas, Dr. Thelwall, 84, Rodney Street, Liverpool.
1889 Thornely, Miss L. R., 17, Aigburth Hall Road.
1903 Timmis, T. Sutton, Cleveley, Allerton, Liverpool.
1888 Toll, J. M., 49, Newsham Drive, Liverpool.
1886 Walker, Alfred O., Maidstone.
1903 Walker, Horace, South Lodge, Princes Park.
1891 Wiglesworth, J., M.D., F.R.C.P., County Asylum, Rainhill.
1896 Willmer, Miss J. H., 20, Lorne Road, Oxton, Birkenhead.

B Associate Members.

1903 Jefferies, F., 45, Trafalgar Road, Egremont.

1903 Tattersall, W., B.Sc., Marine Lab., Moyard, Letterfrack, Co. Galway.

1903 Pearson, J., B.Sc., Belle View Terrace, Larne Harbour, Co. Antrim.

C Student Members.

Bramley-Moore, J., 138, Chatham Street.

Carstairs, Miss, 39, Lilley Road, Fairfield.

Dakin, W., 148, Selborne Street.

Hannah, J. H. W., 55, Avondale Road, Sefton Park.

Harrison, Oulton, Denehurst, Victoria Park, Wavertree.

Hudson, Miss K. B., University Hall, Edge Lane.

Ruete, A., 34, Princes Road, Liverpool.

Scott, Miss D., University Hall, Edge Lane.

Smith, G., University, Liverpool.

Smith, C. H., University, Liverpool.

D Honorary Members.

S.A.S., Albert I., Prince de Monaco, 25, Faubourg St. Honore, Paris.

Bornet, Dr. Edouard, Quai de la Tournelle 27, Paris.

Claus, Prof. Carl, University, Vienna.

Fritsch, Prof. Anton, Museum, Prague, Bohemia.

Giard, Prof. Alfred, Sorbonne, Paris.

Haeckel, Prof. Dr. E., University, Jena.

Hanitsch, R., Ph.D., Raffles Museum, Singapore.

Solms-Laubach, Prof.-Dr., Botan. Instit., Strassburg.

THE LIVERPOOL BIOLOGICAL SOCIETY.

Dr. In Account with THOMAS C. RYLEY, Hon. Treasurer. **Cr.**

Dr.	£	s.	d.
1904, Oct. 1st to 1905, Sept. 30th.			
To Tea and Attendance at Meetings	3	17	6
,, Printing and Stationery	46	10	0
,, Cost of working Lantern	0	10	0
,, Postages and Carriage of Volumes	7	15	0
,, Use of Room at the University	3	3	0
,, Balance	16	10	8
	£78	6	2

Cr.	£	s.	d.
1904, Oct. 1st to 1905, Sept. 30th.			
By Balance of last Account	15	11	8
,, 43 Members' Subscriptions at 21/-	45	3	0
,, 7 Members' Arrears at 21/-	7	7	0
,, 2 Members' Subscriptions in advance at 21/-	2	2	0
,, 2 Members' Entrance Fees at 10/6	1	1	0
,, 1 Member's Subscription at 10/-	0	10	0
,, 1 Member's Subscription at 7/6	0	7	6
,, 2 Members' Subscriptions at 5/-	0	10	0
,, Sales of Volumes	5	14	0
	£78	6	2
By Balance	£16	10	8

Audited and found correct,

HENRY C. BEASLEY.

Liverpool, *October 13th, 1905.*

TRANSACTIONS

OF THE

LIVERPOOL BIOLOGICAL SOCIETY.

ABSTRACT OF INAUGURAL ADDRESS

ON

MOLLUSCA AND THEIR SHELLS.

BY

ALFRED LEICESTER, PRESIDENT.

[NOTE.—The President gave as his opening address a general survey of the subject, especially from the conchological point of view, as he considered that would be more useful to any young conchologists present than a detailed discussion of minute points in structure. He therefore desires to print only the following abstract of his address.]

The President opened by thanking the Society for the honour they had conferred upon him, and expressed his desire to keep up the interest of the meetings and the high reputation of the Society. He alluded to the loss that the Society had recently sustained in the death of its first President, Emeritus-Professor Sir William Mitchell Banks, and recalled how Prof. Banks in his opening address in 1886 gave reasons for the existence of the Society, and said:—"In every great city there are numbers of men who for their own pleasure and recreation have dug deeply into nooks and corners of the great mines of Natural History and Botany, and who can bring to the surface many a bit of rare and valuable ore." The President then paid a tribute of respect and honour to Sir William Banks, and expressed the sorrow of the Society and their sympathy with the family in the loss they had sustained.

He then pointed out the value of the study of some branch of Natural History to men engaged in busy

commercial life at the present day, and drew attention to the interest of, and the intellectual pleasure to be derived from, the collection and classification of shells—as well as the chance of " bringing a bit of valuable ore to the surface " in the solution of some of the many questions still unsettled in regard to the Mollusca and their Shells.

Helix was then described as a type of the land shells, and hints were given as to the occurrence of the species, and the best means of collecting them. The formation and repair of the shell, and the habits of the animal were discussed ; and a Bivalve Mollusc was then contrasted with the Snail, and Chiton with both.

Most of the rest of the Address was occupied by a rapid survey of the leading families of Mollusca for the purpose of bringing out points of interest, both in structure and in habit. This was illustrated by many specimens from the President's conchological collection. Useful suggestions were also given as to the best mode of proceeding on a dredging expedition and when collecting on the sea shore. Some figures were given of the amount of edible shell fish brought weekly into London and elsewhere, in order to show the importance of the industry.

The President concluded by recommending to collectors the prolific grounds round the South end of the Isle of Man, within easy reach of the admirable facilities for work afforded by the new Biological Station at Port Erin ; and he appealed for further workers in all branches of Marine Biology, since "it is by the co-operation of many workers and the exercise of many minds that we can best advance that natural knowledge in which this Society is so much interested."

THE
MARINE BIOLOGICAL STATION AT PORT ERIN,

BEING THE

EIGHTEENTH ANNUAL REPORT

OF THE

LIVERPOOL MARINE BIOLOGY COMMITTEE.

The past year has been a most successful one so far as regards work. We have had a larger number of students at the Laboratory than in any previous year, the average length of time spent by each in work has been greater, we have had more investigators engaged in original research, we have had greater success in our public meetings, more has been achieved in the fish hatching operations—but at the same time the number of our subscribers is not increasing.

We have this year again a loss by death to record. Dr. Isaac Roberts, F.R.S., was a member of the Committee from its foundation and a constant subscriber to the funds. In the early days, before Dr. Roberts moved from Liverpool, he frequently took part in our dredging and other expeditions. He was keenly interested in all branches of Natural Science, and his great reputation as an original worker in Astronomy must not be allowed to conceal the fact that he was also widely known as a Geologist, had considerable acquaintance with Marine Biology, and was not only a Field Naturalist in his sympathies but also by virtue of his observations. Before the days of University College or the initiation of the present scheme of work, he had made observations on the constituents of the sandbanks in Liverpool Bay, and had

written on their contained species of shells. He always on our expeditions took the greatest interest in the dredging and sounding operations, and during the first year of work presented to the Committee a Negretti and Zambra deep-sea reversing thermometer for recording the temperatures of the water at the bottom.

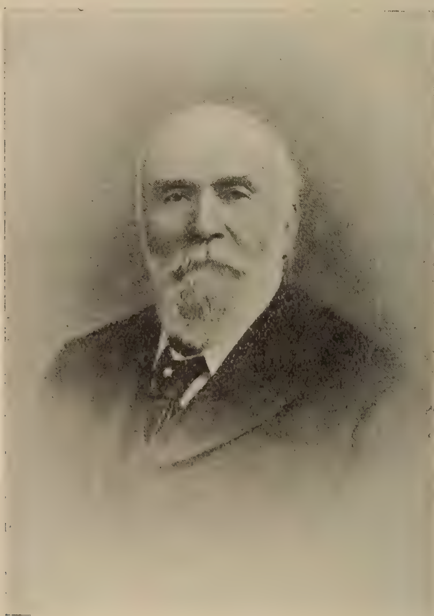


FIG. 2. Dr. Isaac Roberts, F.R.S., F.G.S.

Although Dr. Roberts' removal from Liverpool to the South of England prevented him from taking an active part in the work of the Committee, still he always retained his interest in the work, wrote and sent appreciative messages in regard to its progress, and continued to encourage and support it. We are indebted to Mrs. Isaac Roberts for the accompanying illustration from a photograph of our late member.

These successive losses of our old tried supporters and fellow-workers are very sad, and it becomes increasingly difficult to find similar men, of scientific tastes, in the younger generation prepared to fill the vacant places and devote some time and energy to advancing knowledge of the Natural History of our local seas.

Last year's vacancies on the Committee were filled, at the Meeting held at Easter, in the Biological Station, by the election of Sir Charles Petrie and Mr. W. J. Halls. Both gentlemen have consented to serve on the Committee. Mr. Halls has been with us as a worker for many years, and Sir Charles Petrie has shown his interest in the past in all Marine Biological investigations.

The Committee decided at the Easter Meeting not to fill up, for the present, the post of Hon. Secretary and Treasurer; but requested Mr. Edwin Thompson to kindly continue in office for a time as Acting Treasurer. Mr. Thompson's Report and Balance Sheet will be found appended. The Committee would gladly welcome more fellow-workers—in the form either of Naturalists who will come to the Biological Station and take part in the investigations, or of sympathisers who will help to the extent of an Annual Subscription to the funds.

The Biological Station.

The improvements contemplated in last year's Report have now been effected. The tanks on the central tables in the Aquarium (see fig. 3) have been connected up to the system of circulating sea-water. The Museum in the Gallery has been improved, and a useful verandah has been added at the back of the institution, to be used in part by students in the Laboratory for the sorting out of collected material before being taken to the work rooms, and partly as an annexe to the Fish Hatchery, in which

animals not required within doors can be kept in tanks under shelter, but exposed to the fresh air.

The windows of the ground floor have been greatly improved by the removal of the heavy wooden sashes and common glass, now replaced by continuous plate glass, which gives much more light to the laboratories. The discarded windows will be used for glazing in the verandah. The whole of the outside iron and woodwork has also been

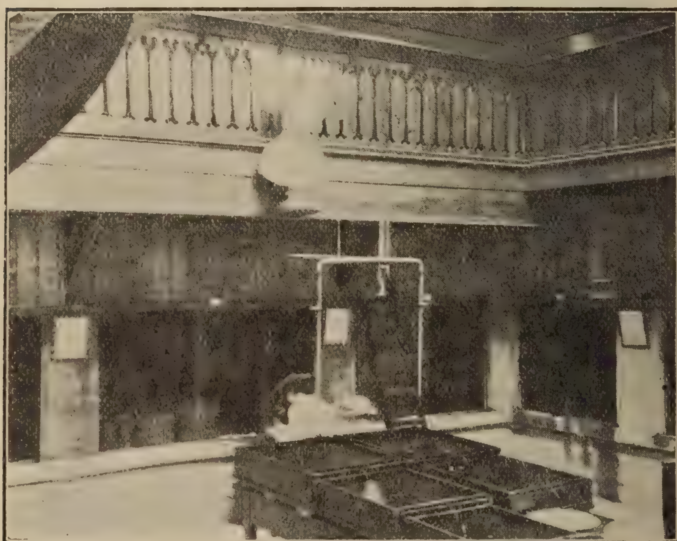


Fig. 3. Interior of the Aquarium. From a photo by Mr. Edwin Thompson.

re-painted. The varnishing of the interior will have to be undertaken soon. There are many other minor improvements which are only postponed from want of funds.

A new high-level storage tank for sea-water has been placed on the cliff behind the building. This useful addition, which gives a much-needed supply of water to the Aquarium and upper Laboratory, was paid for by part of

the profits derived from the visitors to the Aquarium and Museum during last year.

The Fish Pond is now in perfect condition, and has proved most satisfactory in its working during the year. Further particulars in regard to its contents will be given in a later part of this Report. There is nothing new to be stated in regard to other parts of the building. They have all been occupied to their fullest extent on occasions during the year, and all departments continue to give satisfaction to those who have used them.

The Station Record.

During the past year the following naturalists and students have occupied workplaces in the Biological Station, in addition to the Curator (Mr. Chadwick), who has been in constant attendance.

Date.	Name.	Work.
March 25th to April 7th	Miss Steele, M'chester University Miss Saxelby, do. Miss McNicol, do. Miss Geiler, do.	Marine Algæ.
March 29th to April 9th	Mr. C. Gordon Hewitt, Manchester University Mr. R. H. P. Hick, Cambridge...	Development of Echinus and Isopoda.
April 1st to April 4th	Mr. A. Leicester, Liverpool ...... Mr. W. J. Halls, do.	Mollusca.
April 1st to April 9th	Mr. F. J. Cole, L'pool University Mr. J. H. Wadsworth, Manchester University	General.
April 2nd to April 9th	Miss Cussans, B.Sc., L'pool Univ....	Paguridæ.
	Miss Dennant, Liverpool .... Mr. Shepherd, Castletown......... Mr. Dickinson, Manchester	Nature Study.
April 5th to April 19th	Mr. W. Gunn, Liverpool Univ. ...	General.
April 6th to April 19th	Miss Stocks, Manchester Univ. ...	Tunicata.

Date.	Name.	Work.
April 7th to April 19th	Miss E. Farmer, Liverpool Univ.	General.
April 4th to April 15th	Mr. Dakin, Liverpool University	General.
March 29th to April 22nd	Prof. Herdman, Liverpool Univ.	Official.
April 12th to April 18th	Mr. R. D. Laurie, Oxford	General.
May 20th to May 24th	Prof. Herdman	Official.
June 21st to July 28th	Mr. F. A. Potts, Cambridge	General & Mollusca.
June 25th to June 27th	Prof. Herdman	Official.
June 27th to July 8th	Mr. F. H. Graveley, Manchester University	Hydroida.
July 8th to July 27th	Mr. W. Bygrave, Cambridge	General.
July 12th to August 3rd	Mr. T. H. Burlend, Cambridge	General.
July 22nd to September 19th	Prof. Herdman, Liverpool Univ.	Molluscan Histology
	Miss W. Herdman, do.	Marine Algæ.
July 22nd to July 26th	Mr. J. Lomas, Liverpool Univ.	Structure of shells.
July 26th to August 17th	Mr. A. D. Imms, B.Sc., Birmingham University	Marine Insects.
August 2nd to August 5th	Miss Foster, Sheffield	General.
August 5th to August 12th	Mr. R. D. Laurie, Oxford	Variation in Mollusca.
	Prof. Moore, Liverpool Univ.	Experimental work.
August 6th to August 16th	Mr. C. J. Thompson, Birmingham University	General.
August 8th to September 1st	Miss Lloyd Jones, B.Sc. Manchester University	Hydroida and Tunicata.

Date.	Name.	Work.
August 10th to August 16th	Mr. H. A. Whitcombe, Birmingham University	General.
August 12th to September 2nd	Mr. W. D. Shuard, London	General.
August 29th to September 11th	Mr. F. W. Headley, Haileybury College	Development of Aplysia and Tunicata.
September 3rd to September 21st	Dr. J. H. Ashworth, Edinburgh University	Arenicola, and development of Tapes.
September 27th to October 1st	Prof. Herdman, Liverpool Univ.	Official.
October 29th to November 1st	Prof. Herdman, Liverpool	Official.
	Miss L. R. Thornely, Liverpool	General.

This list contains 42 entries, and 36 individual workers, who may be arranged as follows under the "Tables" that they occupied:—

Liverpool University Table :—

Professor Moore.
Professor Herdman.
Mr. J. Lomas.
Mr. F. J. Cole.
Miss Cussans.
Miss Farmer.
Miss Winifred Herdman.
Mr. Dakin.
Mr. R. D. Laurie.
Mr. W. Gunn.

Liverpool Marine Biology Committee Table :—

Mr. Chadwick.
Dr. J. H. Ashworth.
Mr. A. Leicester.
Mr. W. J. Halls.

Manchester University Table :—

Miss Steele.
Miss Saxelby.
Miss McNicol.
Miss Geiler.
Miss Stocks.
Miss Lloyd Jones.
Mr. C. Gordon Hewitt.
Mr. F. H. Graveley.
Mr. J. H. Wadsworth.

Birmingham University Table :—

Mr. A. D. Imms, B.Sc.
Mr. H. A. Whitcombe.
Mr. C. J. Thompson, B.Sc.

Isle of Man Natural History Society Table :—

Mr. P. M. C. Kermode.
Mr. R. Okell, F.L.S.

Vacant Tables :—

Mr. R. H. P. Hick.
Mr. F. A. Potts.
Mr. W. Bygrave.
Mr. T. H. Burlend.
Miss Foster.
Miss L. R. Thornely.
Mr. W. D. Shuard.
Mr. F. W. Headley.

Mr. Robert Okell, F.L.S., was a constant visitor and worker throughout the year in his official capacity as Secretary to the Fishery Board. We have had many other distinguished visitors, including his Excellency Lord Raglan, the present Governor, and Sir West Ridgeway, a former Governor of the island, Sir Alan Perry, the Bishop of Liverpool, various scientific men, such as Prof. Lyman Clark, Dr. Gustav Eisen and Mr. Edgar Thurston; and, finally, various public bodies, which are mentioned in the Report of the Curator. The Isle of Man Natural History Society continues to take a deep interest in our work, and during September the members held a well-attended meeting in the Institution. The Society has not had a representative doing continuous work in the Biological Station since Mr. Walter Teare left the island last year, but several of their members, such as Mr. Kermode and Mr. Okell, have been frequent visitors; and the Society has recently appointed Mr. Richard Lace, of Santon, to occupy their work table when he is able to do so. The Acting Treasurer, Mr. E. Thompson, came on business. Mr. Kewley, Science Master at King William's College, has visited the Aquarium, Museum, and Laboratories with a large number of boys, and will, we hope, continue to make use of the Institution in this way for educational purposes.

Many of our University Students have supplemented their biological work in the Laboratory with occasional days devoted to Geology and Archæology on the hills. On some of these occasions we have had the advantage of being accompanied by Mr. Lomas as our leader amongst the rocks, and by Mr. Kermode when examining the prehistoric antiquities. From time to time I have been enabled to take part with Mr. Kermode in the examination or exploration of some of the early Manx remains.

The most notable of these occasions was when, some twelve years ago, we excavated the large circle of stone cists on the Meayll Hill above Port Erin, and the foundations of the neighbouring hut villages. The paper that we wrote on the results of our digging has now been long out of print, and the single copy at Port Erin has been frequently consulted and taken out on loan. Consequently we have now been induced, by many demands from our students and from visitors at the Biological Station, to reprint our former paper, with considerable additions, so that it may constitute an illustrated guide to the more important of the ancient monuments and other remains on the island—and in this form it will be found appended to the present Report. I wish to take this opportunity of stating that the greater part of the labour in connection with this work has fallen upon my friend Mr. Kermode, and that his accumulated mass of notes and drawings has been freely drawn upon. This is only to be regarded as the forerunner of a very much more complete and detailed work dealing with the antiquities of his native land—and especially with the early Celtic and Scandinavian carved crosses*—upon which Mr. Kermode has been engaged for some years.

Notes on Laboratory Work.

Mr. J. Lomas occupied his time at the Biological Station in studying the distribution of Calcite and Aragonite in the layers of various molluscan shells and in testing methods of readily distinguishing between the two minerals.

* Mr. Kermode's labours in rescuing from destruction and in interpreting these early crosses is well known to antiquaries and others who have seen his remarkable collection of casts and drawings at Ramsey.

Mr. R. D. Laurie worked at variation in *Purpura lapillus* in relation to environment. Professor Moore was making preliminary observations with a view to certain Bio-chemical investigations which he wishes to conduct in our tanks during the coming season.

Mr. A. D. Imms was collecting, studying and preserving the marine apterous insect *Anurida* with a view to the L.M.B.C. Memoir on that type upon which he is now engaged. He also collected, in chinks of the shore, 5 examples of a Pseudoscorpion which he identified as *Obisium maritimum*, Leach (confirmed by the Rev. Pickard Cambridge, who adds that this is only the second record of the species since the days of Leach, the other locality being on the coast of Devon).

I was myself working during most of the summer vacation upon Molluscan Histology, and I got several of the advanced students to undertake the investigation of special points in order to test and corroborate my own observations. In that way Mr. Bygrave and Mr. Burlend did some work on the structure of the Lamellibranch gill and the currents produced by the ciliation, and Mr. Potts examined for me the striped and non-striped fibres of the adductor muscles and started an investigation of the byssus gland which I hope he will finish on another occasion.

Mr. C. Gordon Hewitt occupied the Victoria University of Manchester work-table during the Easter vacation, and reports to me as follows:—

"Owing to the stormy weather I was severely restricted in my work on the Isopoda, as it was only possible to go out to sea twice, and even then it was too rough to use the small dredge. I am, however, able to add two species to the known fauna of the district.

"(1) *Idothea pelagica*, Leach.—A single female

specimen was taken in a tow netting in Port Erin Bay. The usual habitat is amongst Algæ at low water mark.

"(2) *Idothea granulosa*, Rathke.—This was found at low water mark in Port Erin Bay. In several respects this form resembles *I. viridis*, Slabber, which Sars considers a distinct species, but although the divergences between the two species are not great in colour, size, shape of coxal plates and metasoma, it agrees with *I. granulosa*. Out of Norway the latter species has not been recorded, so far as I know, except by Mr. A. O. Walker from the West of Ireland, and he tells me that he has very little confidence in the record. The absence of records, however, may well be due to the scarcity of observers and to the superficial resemblance to the immature forms of *I. tricuspidata*. More thorough investigation will no doubt clear up the difficulties in the distribution."

Dr. J. H. Ashworth, of the University of Edinburgh, reports as follows:—

"By Professor Herdman's kind permission I occupied a table in the Laboratory from September 3rd to September 20th. During most of this time I was engaged upon the investigation of certain points in the nervous system of *Arenicola grubii*. This species occurs in fair numbers on the beach near the stone boat jetty, but can be obtained only at the best low tides. *A. ecaudata* also occurs in the same gravel, but is present in much smaller numbers.

"The following notes may be interesting to others who visit the Laboratory during September in future years:

"(1) Specimens of *Tapes pullastra*, which occur in the gravel near the boat jetty were found to be discharging ova from September 9th onwards for about a week. These ova, after being placed in a large volume of sea-water, were readily fertilised by the addition of sperms obtained

from a male specimen, and soon afforded good examples of spiral cleavage. In two days we had in our jars thousands of minute ciliated larvæ, showing various interesting phases.

"(2) In the hope of finding young stages of *Arenicola grubii* or *ecaudata*, I cut off from the blocks of the breakwater a large number of the 'roots' of Laminaria, and brought them into the Laboratory to examine. A few of the more promising were placed in a dish of sea-water overnight. In the morning among other objects found there was a small female *Monstrilla*, still enclosed in a portion of the last larval skin, and therefore only newly liberated from its host. On looking over the 'roots' in the dish I found altogether some thirty specimens of a small tubicolous Polychæte, probably a species of *Salmacina*, and on examination these proved to contain young specimens of the *Monstrilla*. The fact that this material can be obtained at Port Erin may be of use to those who are interested in the peculiar life history of this remarkable Copepod.

"I would here express my sincere thanks to Professor Herdman for putting the resources of the Laboratory at my disposal.—J. H. Ashworth."

As a contribution to the number of eggs produced by Crustacea, it may be useful to record that Mr. Robert Okell, F.L.S., examined two berried specimens of the large spiny lobster or sea crayfish, *Palinurus vulgaris*, from the Aquarium, with the following result:—

No. 1. Weight 5 lbs.

Total eggs weighed 148.53 grms.

300 eggs counted weighed .2468 grms.

Total number of eggs = 180,000.

No. 2. Weight $3\frac{1}{2}$ lbs.

Total eggs weighed 113.43 grms.

300 eggs counted weighed .2478 grms.

Total number of eggs = 137,000.

The eggs were carefully stripped off, dried in blotting paper and weighed in the chemical balance.

Port Erin Tow-nettings.

Mr. Andrew Scott, A.L.S., reports to me as follows:—"The examination of the tow-nettings collected by the L.M.B.C. in various parts of the Irish Sea, which has been carried on from the beginning by my late friend and fellow-worker, Mr. I. C. Thompson, with so much success, as his many reports testify, has, at Professor Herdman's suggestion, been handed over to me. The following notes are based on the investigation of 39 tow-nettings, taken in Port Erin Bay by Mr. Chadwick, between April 23rd, 1903, and September 27th, 1904.

1. Fish Eggs.

1903—April	23	Dab.
May	6	Turbot and Dragonet.
,,	11	Pollack, Turbot, and (?) Norwegian Topknot.
,,	19	Dragonet.
,,	23	Pollack, Rockling, Dragonet, and (?) Norwegian Topknot.
June	3	Dragonet.
,,	8	Turbot, and Rockling.
,,	22	Brill, and (?) Norwegian Topknot.
July	9	Rockling, Poor Cod, and Turbot.
,,	14	,, ,, ,,
,,	17	,, ,, Turbot & Gurnard.
,,	22	,,
Aug.	11	,, Turbot and Weaver.

1904—Feb.	4	Cod.
March	2	,, Plaice and Dab.
April	19	,, and Turbot.
May	4	Haddock, Dab, Megrim, Flounder, and Dragonet.
,,	26	Haddock.
June	4	Whiting, and (?) Norwegian Topknot.
,,	22	Turbot, and Solenette.
,,	27	Lemon Sole, Dab, and Rockling.
July	4	Dab, and Rockling.
,,	16	Rockling.

The identification of preserved fish eggs is attended with many difficulties, and the names can only be regarded as approximately correct, except in a few cases where the characters are so marked that there need be no hesitation in ascribing certain eggs to particular fishes.

2. Post Larval and Young Fishes.

These do not appear to be often taken in surface collections, and their presence has only been noted on two occasions during the period covered by these notes. Two Post-larval Gadoids were taken on May 23rd, 1903. Twelve young Gadoids, 7·5 mm. to 10 mm., and one young Trigla 9·5 mm. in length, occurred in the tow-netting taken on June 4th, 1904.

3. Annelida.

Sagitta were present in 38 out of the 39 collections. The only gathering in which they were absent was the one taken on May 11th, 1904.

Tomopteris occurred in July, September, November, 1903, and January, April, May, June, and September, 1904.

Autolytus were found in September, 1903, and March, April, June, 1904.

4. Diatoms.

Coscinodiscus and *Biddulphia* were very abundant in the collections taken in April and the early part of May, 1903. These forms gradually decreased and finally disappeared towards the end of June. By the middle of October both genera had reappeared, and continued to increase in quantity; the maximum point in 1904 was reached early in March; none were observed after June 22. On September 27th, 1904, *Coscinodiscus* had just made its appearance again. *Chætoceros* was observed once in 1903 (September 28). In 1904 it was noted in the collections taken in January, February, March, April, and first half of May. None were seen again till September 27, when it was again very abundant.

Rhizosolenia was only noted once during the whole period covered by the 39 tow-nettings (May 11th, 1904).

The gelatinous algæ which frequently chokes up the tow-nets in the summer months, appeared in Port Erin on May 26th, 1903, and remained till July 9th. During 1904 this alga only occurred on May 4th and 11th although it was very abundant off the Welsh and Lancashire coasts during June and July.

5. Protozoa.

Representatives of this group occurred very sparingly, and the only forms noted were *Ceratium fusus*, March 2, 1904, and *Ceratium tripos*, November 7, 1903, September 10th and 27th, 1904. A species of *Acanthometra* was very frequent in the tow-nettings taken on

February 4th and 10th, 1904. We have noticed it in various parts of the Irish Sea in previous years, but have never recorded its occurrence.

6. Coelenterata.

Pleurobrachia was noted in August, September, October and December, 1903, and May, June, July and September, 1904. The pelagic eggs of *Alcyonium* were only observed on January 6th and May 4th, 1904.

7. Crustacea.

Copepoda were found in every tow-netting, and in many cases were abundantly represented. The prevailing form appeared to be *Pseudocalanus*, and was found in every collection. *Temora* was present from April 23rd to November 7th, 1903, but was entirely absent from the collections taken onward to May 26th, 1904. It then reappeared, and was represented in every subsequent gathering. *Calanus finmarchicus*, although rare, was only entirely absent in December, 1903, and January, 1904. *Acartia clausi* was, on the whole, more abundant than *Calanus*—the only months it was not noted were December, 1903, January and April, 1904. *Centropages hamatus* was only present in May, June, July, September, 1903, and May, June, July, August, September, 1904. *Oithona helgolandica*, although present throughout the whole period, was never represented by more than a few specimens. The other Copepoda, such as *Paracalanus parvus*, *Anomalocera*, *Parapontella* and *Isias* were only found on one or two occasions.

Cladocera were represented by *Evadne nordmanni*, *Podon intermedium*, and *Podon leuckartii*. These were only observed in the collections taken during May and June, 1903, and May, June, July, September, 1904. *Podon leuckartii*, G. O. Sars, has not previously been recorded from the L.M.B.C. area.

The Larval stages of some of the Crustacea at certain times of the year make up a considerable portion of the surface plankton. The following are the most prevalent: (*a*) Copepod Nauplii—these were only absent during July, October, November, December, 1903, and July, 1904. (*b*) Cirripedia larvæ. The Nauplii of barnacles are sometimes so abundant that tow-nettings taken in the spring appear to consist of little else than these larvæ. They were only observed in April and May, 1903 and 1904. The "Ostracod" stage were found in May and June, 1903 and 1904. (*c*) Crab "zoea" occurred during April, May, June, July, August, September, 1903, and April, May, June, 1904. The "megalopa" were present during July, August, September, 1903, and September, 1904. (*d*) Larval Crangon were noted for May, June, July, August, September, 1903, and April, May, June, July, August, 1904.

8. TUNICATA.

Oikopleura was observed in the tow-nettings taken during May, June, July, October, 1903, and February, April, May, June, July, August, September, 1904. The eggs of Ascidians were only found once, February 10, 1904.

The Aquarium.

This part of our Institution has fully maintained its popularity amongst the visitors to Port Erin, 11,660 of whom paid for admission during the year. Of this number 7,690 were admitted during the eight weeks ended September 10th, the record number for one day being 486 on August 11th. Increased success has been attained in keeping the fishes and invertebrates in health; indeed, but for the accidental obstruction of the circulation in two of the wall tanks the number of deaths would have been quite insignificant. The erection of a second storage tank at a higher level than the original one, and the inclusion of the table tanks in the system of circulation have contributed materially to this result. The attachment of a glass tube to each of the taps over the wall tanks, whereby the incoming water and bubbles of air are carried down to the bottom of the tanks, has been found to ensure an abundance of well-aerated water in every part. Some of the fishes and invertebrates acquired during the spring and summer of 1903 survived the winter, and are still to be seen in the tanks. The group of tube-building worms, *Sabella pavonia*, mentioned in last year's Report as having been obtained from the harbour buoy, have now lived in one of the table tanks for more than twelve months, and have grown considerably during that time. We may also note as old inhabitants some of the specimens of the Spiny Lobster, *Palinurus vulgaris*, one of which cast its shell recently. The dried shell is now to be seen in the Museum collection in the Gallery.

During the early spring considerable progress was made by Mr. Chadwick with the arrangement of the collections of invertebrates and local fishes in the desk and wall cases in the Museum Gallery, and to these a collection of

named marine algæ was added during the spring and summer months by Miss W. Herdman. The Museum is now a valuable adjunct to the Aquarium, the descriptive labels therein adding much to the interest with which many of our visitors watch the movements of the living animals in the tanks.

Remarks upon several other points in connection with the year's work will be found in the Curator's Report to

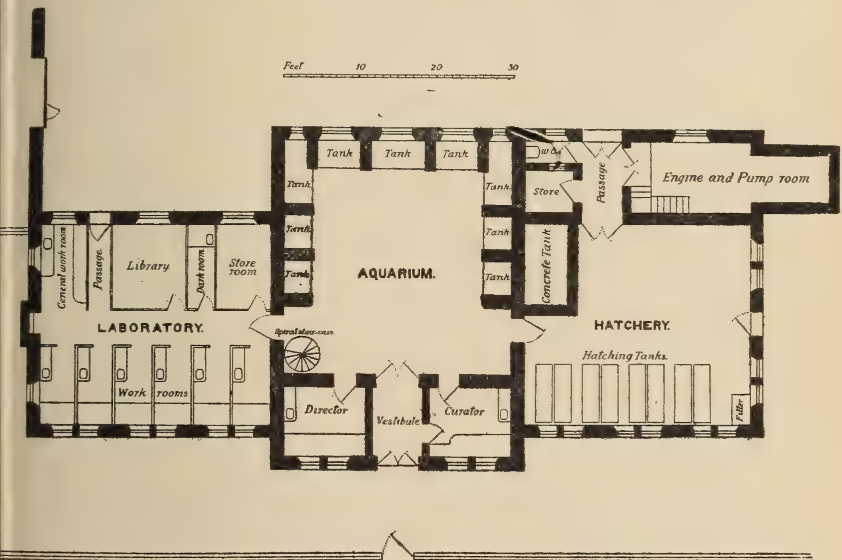


FIG. 4. Plan of Ground Floor of Biological Station.

the Committee, which is appended. Mr. Chadwick has taken advantage of the opportunity afforded by the lobster hatching to prepare careful drawings (figs. 5 and 6) of the characters shown at each moult or period of casting the shell between the newly-hatched larva (fig. 5, 1) and the "lobsterling" stage (fig. 6) after the fourth moult. These figures will be more fully described in the new edition of the "Guide to the Aquarium," now in preparation.

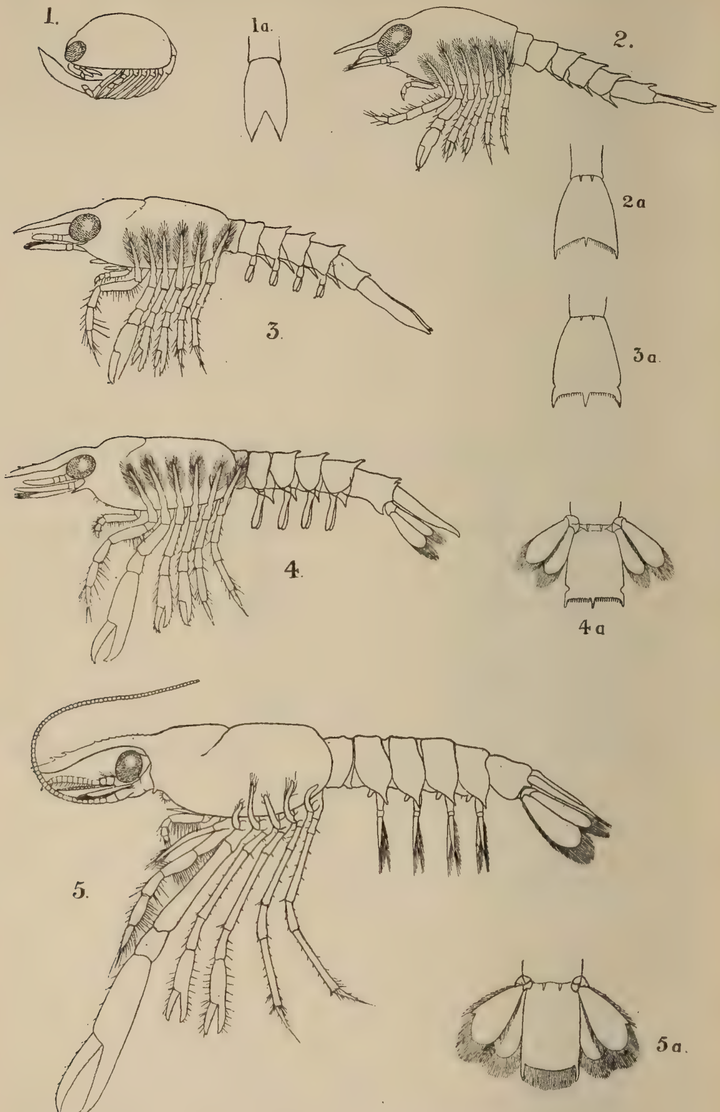


Fig. 5. Stages in the metamorphosis of the young lobster: all × 5.—
1. Larva of lobster as it appears immediately after extrusion from the egg. 1a. The telson viewed from above. 2. Larva of lobster one day old. 2a. The telson viewed from above. 3. Larva of lobster after first ecdysis. 3a. The telson viewed from above. 4. Larva of lobster after second ecdysis. 4a. The tail viewed from above. 5. Larva of lobster after third ecdysis. 5a. The tail viewed from above.

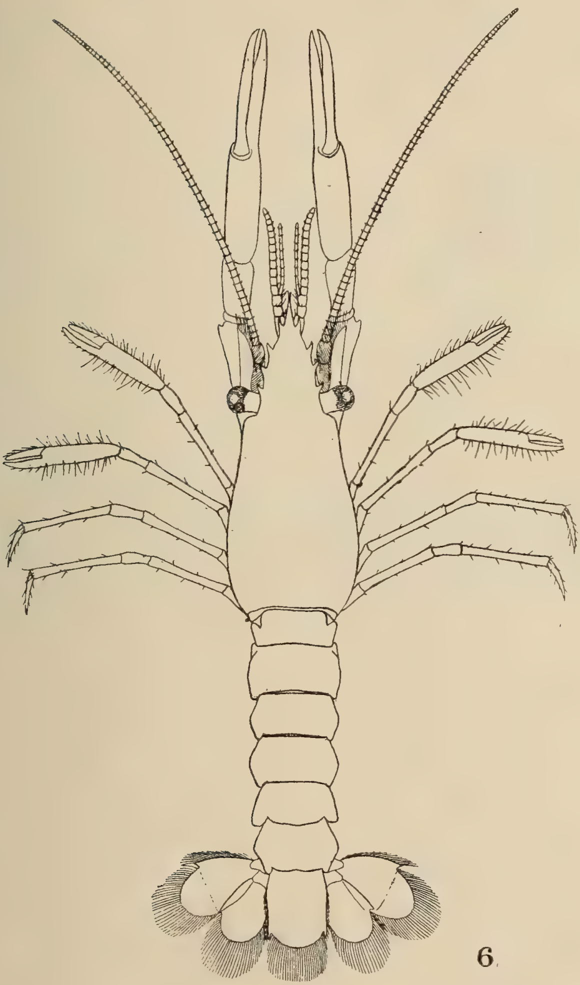


FIG. 6. Number 6. Young lobster, or "lobsterling," after fourth ecdysis, in the attitude assumed in swimming : × 5.
The little animal is now in the stage when it assumes the adult characters.

Sea-fish Hatching and Rearing.

The Economic Fisheries work was carried on quite successfully in the Hatchery last spring, although we have no doubt that still larger numbers will be dealt with in the future. This work is under the control of the Manx Fishery Board; but as the Liverpool Committee and their subscribers and friends will probably be interested to hear of the progress of the hatching and rearing of sea-fish in our district, I shall give here a portion of the Report on the subject which I drew up in June, 1904, for the information of Tynwald Court.

"Honorary Director's Report to the Committee for the Year 1903-1904."

This has been the first year of working with all necessary equipment and with completed apparatus, and it is very satisfactory to be able to report that the work has been carried on efficiently by our resident curator, Mr. Chadwick, and that the results are most encouraging for the future.

The stock of adult plaice for spawning purposes was acquired during the winter months (November 11th to February 27th), by the Lancashire and Western Sea Fisheries steamer "John Fell," which brought in between 70 and 80 fish on the first named date; and Mr. R. Knox's steam trawlers "Rose Ann" and "Tudor Prince," from which small consignments were sent by rail from Douglas to Port Erin, on January 22nd, February 18th, and February 27th. As the open-air spawning pond was not quite ready for their reception, the fish were kept for some time in the three largest tanks in the Aquarium; but on February 1st and 2nd ten of the smaller plaice were transferred to the pond, now water-tight and purified, and the

remainder followed on the 22nd. During a final examination of the pond, at the beginning of the spawning season, it was found that very few fish had died, and that at least 105 healthy plaice remained, which produced abundance of spawn.

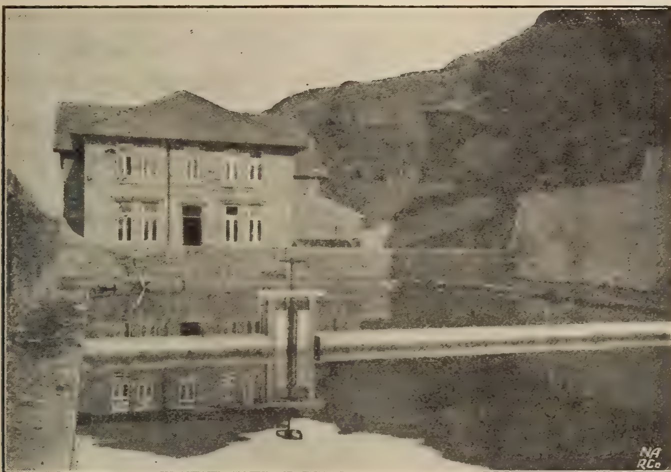


Fig. 7. The Fishpond. From a photo. by Mr. Edwin Thompson.

No difficulty has been experienced in keeping the pond in good condition. Fresh sea-water has been pumped into it almost daily. Green Algæ have grown on the sides, and Diatoms and microscopic animals are present in abundance in the water. The hatching apparatus was fitted-up during the last ten days of January, and was subjected to prolonged soaking, with daily circulation of water for five weeks, before being brought into use. Though susceptible of improvement in certain points of detail, it has worked satisfactorily; the balance apparatus, devised by Mr. Okell, being a distinct improvement upon that at the Lancashire Hatchery at Piel.

The first fertilised eggs of the plaice were found in the pond on March 3rd, and the numbers increased day by day until April 12th, when fully 500,000 were collected. After that date the numbers began to diminish, and none were collected after May 5th.

The method of estimating the number of eggs by measuring the bulk in a graduated cylinder, as followed hitherto and elsewhere, was found to be very destructive; so after a trial, extending over a fortnight, it was replaced by the method of counting measured samples. The numbers of eggs collected during the first fortnight, and estimated by the former method, were as follows:—

Date.	Number of Eggs.
March 10th	10,000
,, 12th	10,000
,, 14th	40,000
,, 15th	25,000
,, 16th	50,000
,, 17th	100,000
,, 18th	18,000
,, 19th	24,000
,, 21st	2,500
,, 22nd	9,000
,, 23rd	11,000
,, 24th	16,000
,, 25th	15,000
,, 26th	12,000
,, 28th	30,000
,, 29th (stormy day) ...	2,000
,, 31st	30,000

After the last date the amount of eggs was estimated by counting the actual number in samples containing 10 c.c. of water taken three or four times from the

hatching box, after a thorough mixing of the contents, and was as follows:—

Date.		Number of Eggs.
April	4th	20,000
,,	9th	50,000
,,	12th	500,000
,,	13th	200,000
,,	14th	50,000
,,	15th	50,000

Eggs in gradually diminishing numbers were collected almost daily until May 5th; but the numbers were not

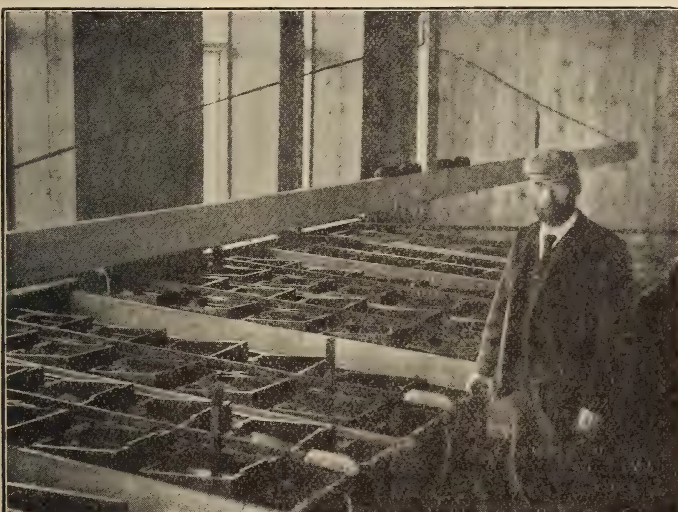


Fig. 8. Interior of the Hatchery, showing the "Dannevig" hatching boxes and Mr. Chadwick. From a photo. by Mr. Wm. Dakin.

estimated, owing to the difficulty of separating the eggs from the larvæ, which were then hatched out in the pond from eggs which had escaped collection on earlier dates.

The first larvæ were hatched out in the boxes on March 30th; and the first liberation of larvæ in the sea

took place on April 10th, when a few thousand were successfully set free in the Calf Sound. On succeeding days larvæ were liberated at sea either to the east or the west of the Calf Island, according to the weather, as follows:—

Date.		Number of Larvæ.
April	11th	30,000
,,	12th	30,000
,,	13th	150,000
,,	14th	130,000
,,	16th	70,000
,,	18th	35,000
,,	21st	184,000
,,	23rd	44,000
,,	27th	50,000
,,	29th	45,000
May	4th	43,600
,,	6th	7,200
		818,800

As all the above numbers are based on minimum countings and estimates, the total is almost certainly greater than that shown; and I think it is safe to conclude that we liberated about a million of healthy young plaice in the open sea. We hope to deal with still larger numbers next year. Our pond will accommodate a much larger number of spawning fish than we had this year. Our hatching boxes will hold more eggs, and we have room to add, if necessary, further ranges of boxes.

We hope, also, to make some improvement in the mechanism and circulation of water, which will prevent a certain wastage of eggs that occurred this season.

It is evident, from questions that have been asked by those who saw the hatching in progress, that some

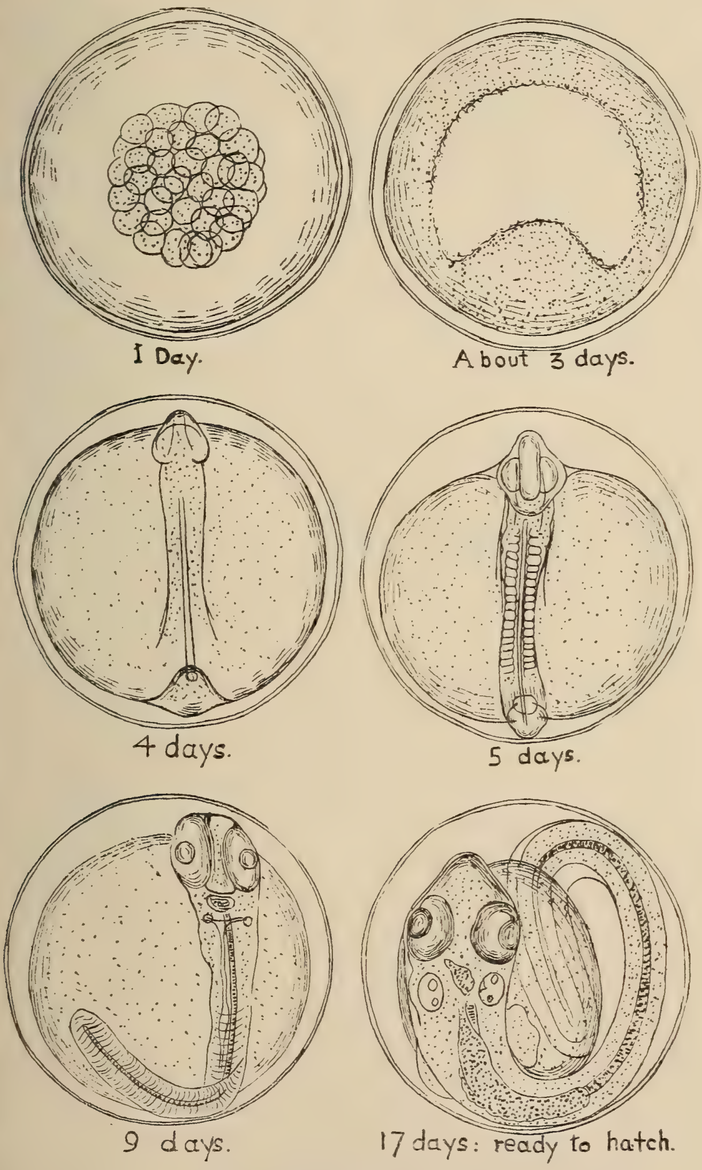


FIG. 9.—Embryonic development of Plaice.

information as to the life-history and habits of the young plaice may be a useful addition to this report.

The average size at which the female plaice becomes mature in our seas is about 14 to 15 inches; and if it were possible to so regulate matters, it would be very desirable, in the interests of the fisheries, that each mature plaice should be allowed to spawn at least once before being caught. The spawning in our seas takes place in the early months of the year—a little earlier or a little later, according to the locality and temperature of the season—but we may say, in general, from January or February to May, with a maximum in March. The fertilised egg is spherical and transparent, floats at the surface of the sea,

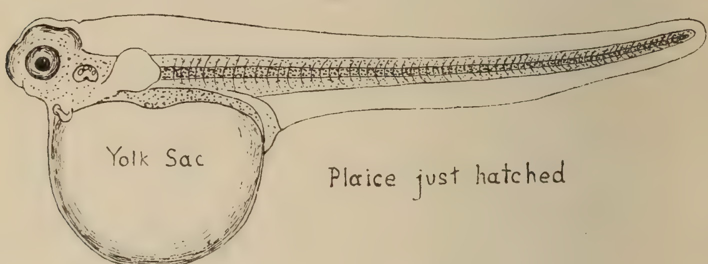


FIG. 10.

and measures about 1-12th of an inch (1·9 mm.) in diameter. The period that the embryo remains inside the egg-covering also depends, to some extent, upon the temperature of the sea water at the time. It may probably vary from a fortnight to three weeks; and 17 or 18 days may be taken as an average time. During the last fortnight of this period the young fish may be clearly seen with the microscope inside the egg-covering (see figure 9, p. 31), and for the last few days before hatching it lies coiled up, and occasionally moving, ready to burst through its shell and emerge as a larva.

When the larval plaice hatches out (see figure 10) it

is about $\frac{1}{4}$ of an inch (7 mm.) in length, and is unable to feed through its mouth; and so for about a fortnight it obtains its nutriment solely from the food-yolk contained in the yolk-sac, which hangs down from the lower surface of the body. During this period it is active and leads a surface life, partly swimming spasmodically by contractions of the muscular tail, and partly drifting passively with the current. It can do little as yet to avoid an enemy, and is easily caught with a small net, a dish, or a dipping tube. After about a fortnight the larva begins to feed. The yolk has then been used up, the jaws have formed, bones have developed in its body, the muscular system is stronger, and the little fish is able to pursue and capture prey, to eat and digest its food. This at first consists of Diatoms, the spores of sea weeds and other vegetable matters, and a little later on of Copepoda and other minute animals. Post-larval stages taken from our pond in May were found when 5 mm. long to be feeding on alga spores, and when 7 mm. on Copepoda.

The young post-larval plaice, when it begins to feed, is about one month old, counting 18 days for hatching and 12 for the absorption of the yolk. Another month is probably required, as a rule, for the transformation of this bilaterally symmetrical little fish into the completely metamorphosed unsymmetrical flat-fish, with both the eyes on one surface (the right side) of the body, and with a distribution of pigment which causes this upper side to be dark-coloured and the lower light. Young plaice, with the metamorphosis completed, have been found only a little over half an inch in length (14 mm.) in June; but they are usually about an inch long when they appear in our sandy bays during the summer. In the post-larval stages they lived at the surface, so during the period of their transformation they must be making their way to

the bottom, and changing their mode of life from the pelagic larval one, where the food is Copepoda and other surface organisms, to that of the ground-living adult, feeding on shellfish and worms.

When floating on the surface as eggs, in the embryonic stages and as larvæ, they are the natural prey of innumerable organisms around them, from medusæ to fishes; and it cannot be doubted that the destruction must be very great, especially in the younger stages. The post-larval forms seem better able to avoid enemies and to take care of themselves; while when the metamorphosis has taken place, they are probably safe from many dangers which threatened them in the earlier periods. Consequently, protection in a hatchery must save a very large proportion of the eggs and larvæ from what would otherwise be their natural fate.

During the present hatching season we have set free our plaice larvæ when between a week and a fortnight after hatching, our object being to keep them as long as possible so as to protect them from destruction in the sea, but to let them out before the yolk-sac was all absorbed and external food required.

No doubt it would be still better if we could safely keep them longer, see them through the period of metamorphosis, and set them free in our bays as young flat-fish. That natural sequel to artificial hatching, viz., rearing the young fish in captivity, will no doubt come; and we are now experimenting in the matter by allowing a certain number of the larvæ to remain developing in our spawning pond. It is satisfactory to find that these are passing through the post-larval period, and are undergoing their metamorphosis. Some have already been seen at the shallower side of the pond as fully formed young flat-fish,

over an inch in length. There seems to be abundance of food, both animal and vegetable, in the water of the pond; and Copepoda have been seen in the stomachs of the young fish.

Finally, in setting free the hatched larvæ, we have been careful to place them in the water well off the land, in a tidal current running clear of the island, so that they should be carried to regions where we find the naturally hatched fish in similar stages, and from which they will find their way gradually, after metamorphosis, into the shore, and appear in due course as young plaice in the shallow waters of our sandy bays.

Since the above was written the young plaice being reared in the pond were seen from time to time throughout the summer, generally lying on the bottom at the shallow end, and darting away very actively when the water was disturbed. At the end of September we decided to run nearly all the water out of the pond and examine the contents for the three-fold purpose of (1) seeing the condition of the bottom; (2) of finding out the exact number and state of our stock of adult fish; and (3) of observing the size attained in a known period by these young plaice. This interesting piece of work, which occupied the greater part of a week, was undertaken during the 26th to 30th of September, with the following result:—

Out of 180 adult plaice which had been added to the pond at various times since the previous autumn (1903), 168 were successfully transferred to the lower and larger sea-water supply tank behind the Hatchery. The condition of these fish was all that could be desired; they were strong and well fed; many were very large. There was evidence (bones) of the death of three fish in all, and five others were found suffering from abrasions of the skin or

fins, and were not returned to the pond, but were put temporarily in hospital tanks in the Aquarium. This leaves four plaice still unaccounted for, but as the water was not entirely drawn off from the deepest corner of the pond these may well have been missed in the probing of the sand at the bottom.

There were found to be very many of the young plaice which had been hatched in the Institution last Easter, from eggs spawned by the larger fish, and so have been under artificial conditions—made as natural as possible—during the whole of their existence. These young plaice, four to five months old, varied from one to four inches in length (the large variation in size is noteworthy), and seemed active and well nourished. The great majority were left as they were in the damp sand and shallow water. From their habit of burrowing in the bottom as the water retreated it was found to be practically impossible to capture them in large numbers, so as to form even an approximate estimate of their quantity. Some hundreds were picked out for experiments in rearing in the small wooden tanks lately fitted up in the verandah. The young plaice examined were found to be feeding mainly on Copepoda.

In the pond there were also shown to be some shrimps, a number of young Gadidæ (the "Bib" and the "Poor Cod"), and a small shoal of young herring (white-bait size). These must have passed through the pumps from the sea, probably in a larval condition. The bottom of the pond was found to be in a satisfactory condition, and many invertebrates, such as Anemones, Ascidians, Polyzoa, Serpulids, and other smaller things, in addition to Algæ, were growing on the stones and sidewalls—showing that plenty of food was being naturally provided for the young fishes.

The pond was then re-filled, and the large plaice successfully put back. Since that time our trammel nets have brought the number up to over 200, and the Lancashire and Western Sea Fisheries steamer "John Fell" has (through the courtesy of the Committee and of the Superintendent, Dr. J. Travis Jenkins) been enabled to spend a day trawling for us, with the result that 110 plaice have been added, making the total of our stock in the pond now somewhere about 320*. From these fish we hope to get abundance of spawn in the coming season.

A number of the young plaice, 4 to 5 months old, that were kept in tanks have since been measured. Four samples, caught by the laboratory boy, and taken as they chanced to come, amounting to 80 fish in all, were of sizes ranging from ¾-inch to 3½-inches; only three of them were over 3 inches, and the majority were between 1½ and 2-inches. A very considerable proportion had a certain amount of dark pigmentation on the lower surface. Out of one batch of 47, 25 showed this ambi-colouration, and only 22 were normal.

Easter Class for School Teachers.

This subject has been referred to in former Reports, and now that the new buildings afford the necessary accommodation, the L.M.B.C. has, in consultation with the Nature-Study Association of Teachers in Liverpool, drawn up the following intimation which was circulated last spring, and is now repeated with a few changes:—

Special Class in Marine Biology, or Nature-Study, for School Teachers, to be held at Port Erin, Isle of Man, during the Easter Holidays, 1905.

The Liverpool Marine Biology Committee, in response

* Of these 118 have been caught at Port Erin during the Summer in our trammel nets.

to a demand, is willing to make arrangements for a special class in Elementary Marine Biology, to illustrate the principles of nature-study, and to be held at the Port Erin Biological Station during the Easter holidays, 1905. The Station is a new building situated on the sea-shore, and is admirably adapted in every respect for classes of this description.

A large laboratory on the first floor, provided with fourteen windows, will be set aside wholly for this purpose during the time of the class. Each member of the class will occupy a table or workplace opposite a window, and will be provided with the necessary animals (or when possible, and as is much better, will be shown how to collect them himself), salt and fresh water, and all materials and apparatus necessary for the work.

The course is necessarily restricted to the Easter holidays, and will extend from a Saturday to a Saturday in April, in the week that is found most convenient to teachers. If, however, any are able and willing to stay for a longer period, further arrangements can be made at the time.

The class will be limited to twelve students, each of whom will pay 5s. to the L.M.B.C. for the use of the laboratory, and in addition a tuition fee of 5s. These fees should be remitted to Mr. Chadwick before the opening of the class. No definite time table of the class work can be drawn up, and the time and nature of the work will depend largely on the tides, weather, &c. Speaking generally, however, the class will spend the morning in the laboratory, examining animals in the living condition, and making simple biological experiments thereon. In the afternoons collecting excursions, with the object of studying the animals in their natural surroundings, and also expeditions for collecting and dredging from boats,

will be organised and led by members of the L.M.B.C. At other times short addresses and demonstrations in the aquarium and museum will be given by Prof. Herdman, and possibly others. No previous knowledge will be supposed. The class work will be directed by Mr. F. J. Cole, Lecturer and Demonstrator of Zoology, University of Liverpool.

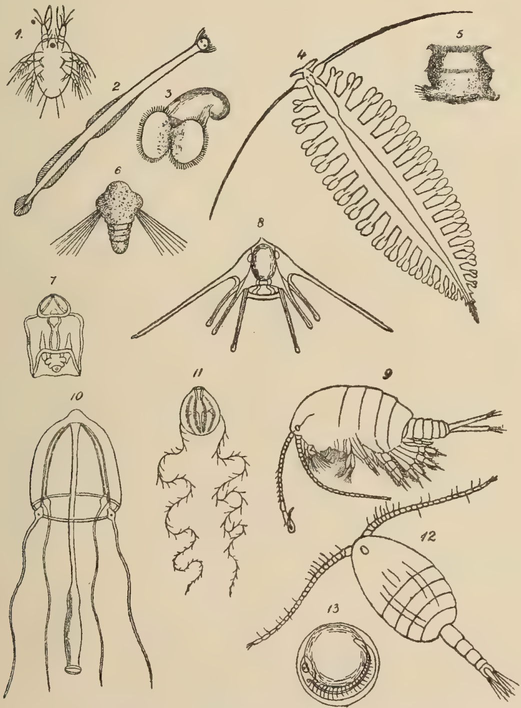


FIG. 11. Plankton or Surface-life of the Sea at Port Erin.

The Treasurer of the L.M.B.C. wishes to point out that, as the charge is at about one half the usual rate for accommodation, it must be regarded as a special charge for this occasion, and for a class of not less than ten or twelve, and will not apply to single students or at other times.

Each member of the class must come provided with a large drawing-book, pencils and india-rubber and a duster or small towel. All further apparatus, as follows—enamelled dissecting dishes, with wax at the bottom, several crystallising dishes and watch glasses, microscope slides and cover-glasses, dipping tubes, some simple dissecting instruments, a magnifying hand lens, occasional microscopes, and collecting jars, will be lent, without charge, by the L.M.B.C., to the students.

If the student wishes to take away any animals for examination at home, bottles, tubes and methylated spirit and other preservatives can be bought from the Station stock on application to the Curator.

Any further details may be arranged and questions asked, before the class commences, by correspondence with Mr. F. J. Cole, University of Liverpool.

L.M.B.C. Memoirs.

The two Memoirs announced in last Report, viz., No. XI., Arenicola, the fisherman's lob-worm, by Dr. J. H. Ashworth; and No. XII., Gammarus, one of the sand-hoppers, by Miss M. Cussans, have been published during the summer. Both are illustrated by fine plates, some of which are coloured.

The Memoirs on Myxine, by Mr. Cole, and on Antedon, by Mr. Chadwick, are both far advanced, and may be looked for during the coming year. The complete list of the Memoirs published and in contemplation is now as follows:—

Memoir I. Ascidia, W. A. Herdman, 60 pp., 5 Pls., 2s.
,, II. Cardium, J. Johnstone, 92 pp., 7 Pls., 2s. 6d.
,, III. Echinus, H. C. Chadwick, 36 pp., 5 Pls., 2s.
,, IV. Codium, R. J. H. Gibson and Helen Auld, 26 pp., 3 Pls., 1s. 6d.

Memoir V. ALCYONIUM, S. J. Hickson, 30 pp., 3 Pls., 1s. 6d.
,, VI. LEPEOPHTHEIRUS AND LERNÆA, Andrew Scott, 62 pp., 5 Pls., 2s.
,, VII. LINEUS, R. C. Punnett, 40 pp., 4 Pls., 2s.
,, VIII. PLAICE, F. J. Cole and J. Johnstone, 260 pp., 11 Pls., 7s.
,, IX. CHONDRUS, O. V. Darbishire, 50 pp., 7 Pls., 2s. 6d.
,, X. PATELLA, J. R. A. Davis and H. J. Fleure, 84 pp., 4 Pls., 2s. 6d.
,, XI. ARENICOLA, J. H. Ashworth, 126 pp., 8 Pls 4s. 6d.
,, XII. GAMMARUS, M. Cussans, 55 pp., 4 Pls., 2s.

MYXINE, F. J. Cole.
ANTEDON, H. C. Chadwick.
BUCCINUM, W. B. Randles.
BUGULA, Laura R. Thornely.
OYSTER, W. A. Herdman and J. T. Jenkins.
OSTRACOD (CYTHERE), Andrew Scott.
PORTUNUS, J. Pearson and W. Tattersall.
CYCLOPORUS, F. F. Laidlaw.
DENDRONOTUS, J. A. Clubb.
ANURIDA, A. D. Imms.
PERIDINIANS, G. Murray and F. G. Whitting.
ZOSTERA, R. J. Harvey Gibson.
HIMANTHALIA, C. E. Jones.
DIATOMS, F. E. Weiss.
FUCUS, J. B. Farmer.
BOTRYLLOIDES, W. A. Herdman.
CUTTLE-FISH (ELEDONE), W. E. Hoyle.
ACTINIA, J. A. Clubb.
HYDROID, E. T. Browne.
CALCAREOUS SPONGE, R. Hanitsch.

In addition to these, other Memoirs will be arranged

for, on suitable types, such as *Sagitta* (by Mr. Cole), a Cestode (by Mr. Shipley), an Isopod (by Mr. C. G. Hewitt), and a Pycnogonid.

As to our other L.M.B.C. publications, a sixth volume of the "Fauna" will soon be issued. Copies of most of the Annual Reports can still be had. Many of them have some special Appendix or characteristic feature in addition to the routine work of the year. For example, No. 6 (1893) has the account of the opening, by Sir Spencer Walpole, of the old Biological Station, No. 13 (1899) has Notes on the Plankton of Port Erin, No. 14 (1900) gives faunistic charts and lists of the bay and the neighbourhood, No. 15 (1901) has as an Appendix the illustrated "Guide to the Aquarium," No. 16 (1902) contains the description and figures of the new Biological Station, while in our last Report (No. 17) there appeared the portrait and Memoir of our late Hon. Treasurer, Mr. Isaac C. Thompson, F.L.S.

The copies of the "Guide to the Aquarium," which are on sale at the Biological Station, will probably be exhausted this season. An enlarged second edition, with additional matter and some new illustrations, is now in preparation.

We append to this Report:—

A—The Curator's Report to the Committee.

B—The Constitution of the L.M.B.C., and the Laboratory Regulations.

C—The Acting Hon. Treasurer's Statement (which will be found at p. 52), with the usual List of Subscriptions and Balance Sheet.

D—Illustrated Notes on Manks Antiquities, by P. M. C. Kermode and W. A. Herdman.

Appendix A.

Curator's Report to the Committee.

The work of the past year has been marked by a substantial increase in the number of University Students who have visited the Station for the purpose of study and research, and by the successful inauguration of fish hatching. Owing to the large demands made upon my time by the hatchery work, I was unable to conduct the Easter Class for School Teachers, but my place was ably filled by Mr. F. J. Cole, and the class was quite successful, in spite of the small number of students in attendance. Our laboratory accommodation was somewhat severely taxed during the month of April, which included the Easter vacation, but no serious inconvenience was experienced either by workers or staff.

The hatching season was practically over by the end of the first week in May, by which time large numbers of plaice larvæ were seen swimming actively at or near the surface in the spawning pond. On May 20th some of these larvæ were examined under the microscope by Prof. Herdman, and their stomachs were seen to contain Copepoda. By the middle of June many had passed through their metamorphosis, and had made their way to the bottom of the pond, and when the pond was emptied during the last week in September they were found to have attained an average length of $1\frac{1}{2}$ to 2 inches, while some few reached 4 inches. A number of berried lobsters were acquired during the winter months and kept in the large concrete tank, with their eggs intact, until a few weeks before the beginning of the lobster hatching season, when, as has been the case elsewhere, all the eggs dis-

appeared, whether eaten by the adult lobsters or simply shed could not be ascertained. However, a few more berried females, with nearly ripe eggs, were brought in by fishermen, and from these 5,000 larvæ were successfully hatched out. In spite of the exercise of every care numbers died during the shell-casting periods, and very few survived to attain the "lobsterling" stage. It is worthy of note that the female spiny lobster, *Palinurus vulgaris*, destroys her eggs in captivity. The specimens in our Aquarium tanks are frequently seen to comb the bunches of eggs with the claws of the last pair of thoracic appendages, and finally all the eggs disappear.

With a view of adding to our stock of adult plaice for spawning purposes, and making the collection of fishes in the Aquarium tanks more representative, a trammel net, 20 fathoms long, was purchased in July, and has been used on almost every suitable day since. The result was so satisfactory that a second net, 30 fathoms long, was purchased in September. In addition to 118 plaice, many of which ranged from 16 to 22 inches in length, various other fish have been caught, including dog-fish, thornback ray, cod, pollack, coal-fish, gurnard, mackerel, conger, angler, wrasse, sole, lemon sole, and dab. The nets have not only added materially to our stock of fish, but have afforded a useful and interesting indication of the species frequenting the bay and neighbourhood during the time they have been in use. In this connection it may be mentioned that a mackerel was caught on November 1st, a late date for this fish in this part of the Irish Sea.

During the first fortnight in August enormous numbers of young herrings, from 2 to 3 inches in length, were left stranded by almost every receding tide on the Manx coast. It was found that they were being pursued and eaten by the shoals of pollack, coal-fish, and mackerel

which always frequent the coast at that time of the year, and so eager and relentless was the pursuit that many of these fish were caught in quite shallow water in Port Erin Bay. The stomach of a pollack caught in the trammel net was found gorged with young herrings.

Tow nettings have been taken at intervals throughout the year. Whenever possible the organisms were examined alive immediately after capture, but the more detailed examination, especially of the Copepoda, has this year been undertaken by Mr. A. Scott, who will submit an independent report.

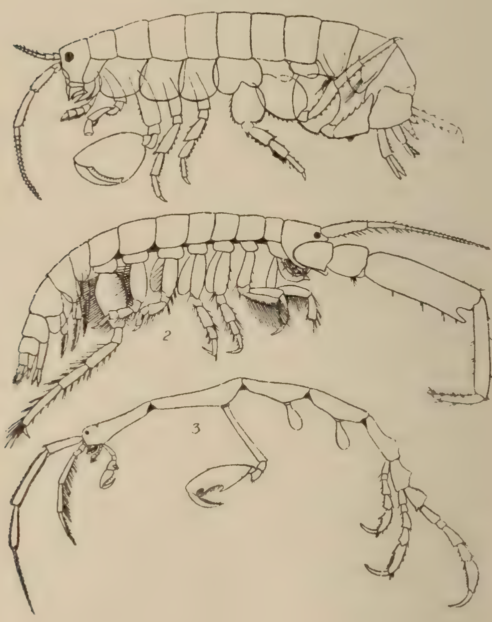
Faunistic work was carried on by most of the University Students, several of whom will contribute notes on points of special interest. Additions continue to be made, by purchase and donation, to the stock of books and reprints in the Library; but such valuable publications as the Quarterly Journal of Microscopical Science and the Journal of the Royal Microscopical Society and many foreign journals are still a much felt want.

The Station has been visited during the year by his Excellency the Lieutenant-Governor of the Isle of Man, Lord Raglan, who has shown his interest in the work of the Institution by repeated visits; also by Sir J. West Ridgeway, formerly Governor of the island, and Sir Alan Perry, by the Speaker of the House of Keys, the Mayor and Corporation of Douglas, the Town Commissioners of Peel, Ramsey, and Castletown, and by the Isle of Man Fishery Board, by Professor and Mrs. Lyman Clark, of Michigan, U.S.A., the Lord Bishop of Liverpool and Mrs. Chavasse, Dr. Gustav Eisen, of San Francisco, Mr. Edgar Thurston, of Madras, and Masters and Boys from King William's College. Lastly, the Isle of Man Natural History and Antiquarian Society held one of their ordinary meetings, under the presidency of Lord Raglan,

in the Lecture Room of the Biological Station on September 15th, when Prof. Herdman delivered an address on "Pearl Oysters and the formation of Pearls." During the Easter vacation Dr. and Mrs. Bailey, of Port Erin, repeated their kind invitation of last year to all our workers, and a most enjoyable evening was spent in examining Dr. Bailey's collection of Manx Beetles.

Port Erin, Nov., 1904. H. C. CHADWICK.

1 *Orchestia littorea* 2 *Corophium grossipes*
3 *Caprella linearis*



Appendix B.

THE LIVERPOOL MARINE BIOLOGY COMMITTEE (1904).

His Excellency the Right Hon. Lord Raglan, Lieut.-Governor of the Isle of Man.

Mr. R. D. Darbishire, B.A., F.G.S., Manchester.

Prof. R. J. Harvey Gibson, M.A., F.L.S., Liverpool.

Mr. W. J. Halls, Liverpool.

Prof. W. A. Herdman, D.Sc., F.R.S., F.L.S., Liverpool, Chairman of the L.M.B.C., and Hon. Director of the Biological Station.

Dr. W. E. Hoyle, M.A., University, Manchester.

Mr. P. M. C. Kermode, Ramsey, Isle-of-Man.

Mr. A. Leicester, Liverpool.

Sir Charles Petrie, Liverpool.

Dr. Isaac Roberts, F.R.S. (the late).

Mr. A. O. Walker, F.L.S., J.P., formerly of Chester.

Mr. Arnold T. Watson, F.L.S., Sheffield.

Curator of the Station—Mr. H. C. Chadwick.

Assistant—Mr. T. N. Cregeen.

CONSTITUTION OF THE L.M.B.C.

(Established March, 1885.)

I.—The Object of the L.M.B.C. is to investigate the Marine Fauna and Flora (and any related subjects such as submarine geology and the physical condition of the water) of Liverpool Bay and the neighbouring parts of the Irish Sea and, if practicable, to establish and maintain a Biological Station on some convenient part of the coast.

II.—The Committee shall consist of not more than 12 and not less than 10 members, of whom 3 shall form a quorum; and a meeting shall be called at least once a year for the purpose of arranging the Annual Report, passing the Treasurer's accounts, and transacting any other necessary business.

III.—During the year the Affairs of the Committee shall be conducted by an Hon. Director, who shall be Chairman of the Committee, and an Hon. Treasurer, both of whom shall be appointed at the Annual Meeting, and shall be eligible for re-election.

IV.—Any Vacancies on the Committee, caused by death or resignation, shall be filled by the election at the Annual Meeting, of those who, by their work on the Marine Biology of the district, or by their sympathy with science, seem best fitted to help in advancing the work of the Committee.

V.—The Expenses of the investigations, of the publication of results, and of the maintenance of the Biological Station shall be defrayed by the Committee, who, for this purpose, shall ask for subscriptions or donations from the public, and for grants from scientific funds.

VI.—The Biological Station shall be used primarily for the Exploring work of the Committee, and the Specimens collected shall, so far as is necessary, be placed in the first instance at the disposal of the members of the Committee and other specialists who are reporting upon groups of organisms; work places in the Biological Station may, however, be rented by the week, month, or year to students and others, and duplicate specimens which, in the opinion of the Committee, can be spared may be sold to museums and laboratories.

LIVERPOOL MARINE BIOLOGICAL STATION
AT
PORT ERIN.

Laboratory Regulations.

I.—This Biological Station is under the control of the Liverpool Marine Biological Committee, the executive of which consists of the Hon. Director (Prof. Herdman, F.R.S.) and the Hon. Treasurer.

II.—In the absence of the Director, and of all other members of the Committee, the Station is under the temporary control of the Resident Curator (Mr. H. C. Chadwick), who will keep the keys, and will decide, in the event of any difficulty, which places are to be occupied by workers, and how the tanks, boats, collecting apparatus, &c., are to be employed.

III.—The Resident Curator will be ready at all reasonable hours and within reasonable limits to give assistance to workers at the Station, and to do his best to supply them with material for their investigations.

IV.—Visitors will be admitted, on payment of a small specified charge, at fixed hours, to see the Aquarium and Museum adjoining the Station. Occasional public lectures are given in the Institution by members of the Committee.

V.—Those who are entitled to work in the Station, when there is room, and after formal application to the Director, are:—(1) Annual Subscribers of one guinea or upwards to the funds (each guinea subscribed entitling to the use of a work place for three weeks), and (2) others who are not annual subscribers, but who pay the Treasurer

10s. per week for the accommodation and privileges. Institutions, such as Colleges and Museums, may become subscribers in order that a work place may be at the disposal of their students or staff for a certain period annually: a subscription of two guineas will secure a work place for six weeks in the year, a subscription of five guineas for four months, and a subscription of £10 for the whole year.

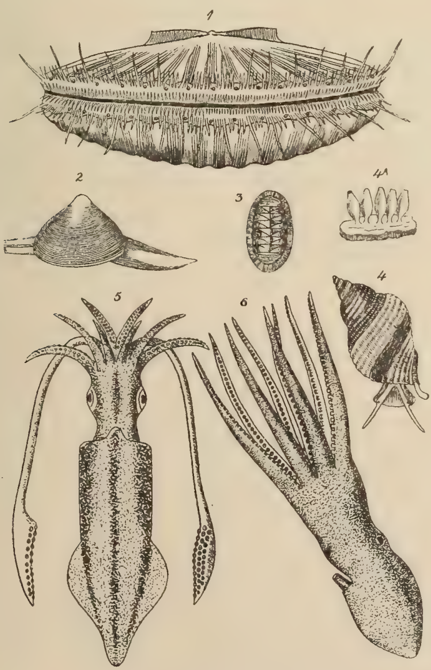
VI.—Each worker is entitled to a work place opposite a window in the Laboratory, and may make use of the microscopes, reagents, and other apparatus, and of the boats, dredges, tow-nets, &c., so far as is compatible with the claims of other workers, and with the routine work of the Station.

VII.—Each worker will be allowed to use one pint of methylated spirit per week free. Any further amount required must be paid for. All dishes, jars, bottles, tubes, and other glass may be used freely, but must not be taken away from the Laboratory. Workers desirous of making, preserving, or taking away collections of marine animals and plants, can make special arrangements with the Director or Treasurer in regard to bottles and preservatives. Although workers in the Station are free to make their own collections at Port Erin, it must be clearly understood that (as in other Biological Stations) no specimens must be taken for such purposes from the Laboratory stock, nor from the Aquarium tanks, nor from the steam-boat dredging expeditions, as these specimens are the property of the Committee. The specimens in the Laboratory stock are preserved for sale, the animals in the tanks are for the instruction of visitors to the Aquarium, and as all the expenses of steam-boat dredging expeditions are defrayed by the Committee, the specimens obtained on these occasions must be retained by the

Committee (*a*) for the use of the specialists working at the Fauna of Liverpool Bay, (*b*) to replenish the tanks, and (*c*) to add to the stock of duplicate animals for sale from the Laboratory.

VIII.—Each worker at the Station is expected to lay a paper on some of his results—or at least a short report upon his work—before the Biological Society of Liverpool during the current or the following session.

IX.—All subscriptions, payments, and other communications relating to finance, should be sent to the Hon. Treasurer. Applications for permission to work at the Station, or for specimens, or any communications in regard to the scientific work should be made to Professor Herdman, F.R.S., University, Liverpool.



Mollusca, from Port Erin.

Appendix C.

HON. TREASURER'S STATEMENT.

As usual, the list of subscribers and the balance sheet are appended, the latter showing a small balance in favour of the Committee. The Report of the Director clearly indicates the necessity there is for increased support by annual subscriptions or special donations, now that the commodious, but more expensive, new Biological Station is in full occupation, and that further fields of useful work are opening up before the Committee.

Professor Herdman reports that no further donations have been made during the year to the special fund for publishing the Marine Biological Memoirs. Several excellent Memoirs are nearly ready for publication, and contributions for this object will be gladly received by Professor Herdman.

The library for the use of students and workers at the Port Erin Station is urgently in want of many standard Biological works. Further donations towards the library, either in books or money, will be most welcome.

The Treasurer will gladly receive the names of new subscribers with the view of continuing the publications on the local Fauna and on typical British marine animals and plants, and of aiding to defray the increased working expenses at the new Biological Station, and of thus further adding materially to the work already achieved under the auspices of the L.M.B.C. since its foundation nineteen years ago.

Edwin Thompson,
Acting Hon. Treasurer.

53, Croxteth Road,
Liverpool, December, 1904.

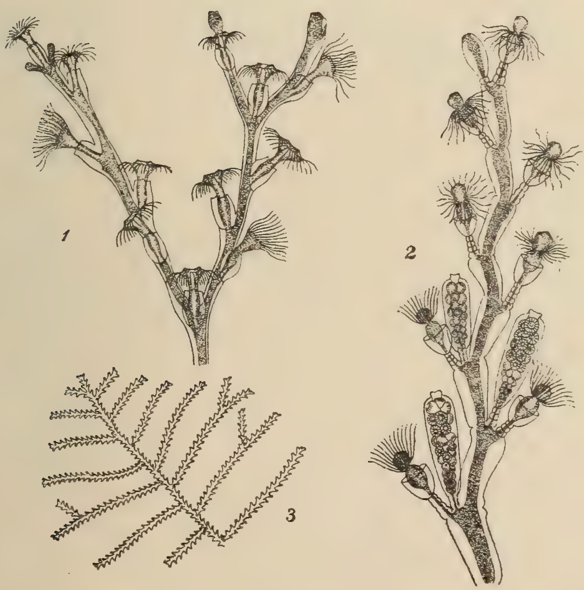
SUBSCRIBERS.

	£	s.	d.
Beaumont, W. I., Citadel Hill, Plymouth ...	1	1	0
Bickersteth, Dr., 2, Rodney-street...	2	2	0
Brown, Prof. J. Campbell, University, Liverpool..	1	1	0
Browne, Edward T., B.A., 141, Uxbridge-road, Shepherd's Bush, London	1	1	0
Boyce, Prof., University, Liverpool	1	1	0
Brunner, Mond & Co., Northwich...	1	1	0
Brunner, Sir J. T., Bart., M.P., Liverpool ...	5	0	0
Clague, Thomas, Bellevue Hotel, Port Erin ...	1	1	0
Clubb, J. A., Public Museums, Liverpool... ...	0	10	6
Crellin, John C., J.P., Andreas, I. of Man... ...	0	10	6
Crosfield, Harold G., Fulwood Park, Liverpool ...	1	1	0
Dale, Principal, University, Liverpool	1	0	0
Dixon-Nuttall, F. R., J.P., F.R.M.S., Prescot ...	2	2	0
Gair, H. W., Smithdown-rd., Wavertree ...	2	2	0
Gamble, Sir David, C.B., St. Helens	2	0	0
Gaskell, Holbrook, J.P., Woolton Wood	1	1	0
Gossage, Fred. H., Camp Hill, Woolton	5	0	0
Halls, W. J., 35, Lord-street	1	1	0
Headley, F. W., Haileybury College, Hertford ...	1	1	0
Herdman, Prof., University, Liverpool	2	2	0
Hewitt, David B., J.P., Northwich	1	1	0
Holland, Walter, Carnatic Hall, Mossley Hill ...	2	2	0
Holt, Alfred, Crofton, Aigburth	2	2	0
Holt, Mrs., Sudley, Mossley Hill	2	2	0
Holt, P. H., Croxteth-gate, Sefton-park	1	1	0
Holt, R. D., 54, Ullet-road, Liverpool	2	0	0
Hoyle, Dr. W. E., Museum, Owen's College ...	1	1	0
Isle of Man Natural History Society	1	1	0
Jarmay, Gustav, Hartford, Cheshire	1	1	0
Jones, Charles W., J.P., Allerton Beeches ...	1	0	0
Forward	£47	10	0

	£	s.	d.
Forward	47	10	0
Lea, Rev. T. Simcox, Leek Vicarage, Kirkby Lonsdale	1	1	0
Leicester, Alfred, Scott Dale, New Ferry... ...	1	1	0
Lewis, Dr. W. B., W. Riding Asylum, Wakefield...	1	0	0
Manchester Microscopical Society...	1	1	0
Meade-King, R. R., 4, Oldhall-street	0	10	6
Melly, W. R., 90, Chatham-street	1	1	0
Monks, F. W., Warrington...	2	2	0
Muspratt, E. K., Seaforth Hall	5	0	0
Okell, R., B.A., F.L.S., Sutton, Douglas, I. of Man	1	1	0
Paterson, Prof., University, Liverpool	1	1	0
Petrie, Sir Charles, Devonshire-road	1	1	0
Pilkington, J. A., Bank House, Maghull	0	10	0
Rathbone, Mrs. Theo., Backwood, Neston... ...	1	1	0
Rathbone, Miss May, Backwood, Neston... ...	1	1	0
Rathbone, W., the late, Greenbank, Allerton ...	2	2	0
Roberts, Dr. Isaac, the late, F.R.S., Crowborough, Sussex	1	1	0
Rae, Edward, Courthill, Birkenhead	1	1	0
Simpson, J. Hope, Aigburth-drive	1	1	0
Smith, A. T., 43, Castle-street	1	1	0
Sorby, Dr. H. C., F.R.S., Broomfield, Sheffield ...	1	1	0
Talbot, Rev. T., Douglas, Isle of Man	1	1	0
Thornely, The Misses, Aigburth-Hall-rd.... ...	1	1	0
Timmis, T. Sutton, Cleveley, Allerton	2	2	0
Toll, J. M., 49, Newsham Drive, Liverpool ...	1	1	0
Walker, Alfred O., Ulcombe Place, Maidstone ...	3	3	0
Walker, Horace, South Lodge, Princes-pk.... ...	1	1	0
Walker, W. H. & Co., Douglas	1	1	0
Watson, A. T., Tapton-crescent, Sheffield... ...	1	1	0
Weiss, Prof. F. E., Owens College, Manchester ...	1	1	0
Wiglesworth, Dr., Rainhill...	1	1	0
Yates, Harry, 75, Shude-hill, Manchester... ...	1	1	0
Yates, Peter P., Grand Hotel, Douglas	1	1	0
	£89	3	6

Subscriptions for the Hire of "Work-Tables."

Victoria University, Manchester	£10	0	0
University, Liverpool	10	0	0
Birmingham University	10	0	0
	£30	0	0



Port Erin Zoophytes.

THE LIVERPOOL MARINE BIOLOGY COMMITTEE.

Dr. IN ACCOUNT WITH EDWIN THOMPSON, ACTING HON. TREASURER. **Cr.**

1904.	£	s.	d.
To Printing and Stationery	32	8	0
,, Expenses of Dredging Expeditions	2	5	0
,, Boat Hire and Boat Repairs	3	12	0
,, Books and Apparatus at Port Erin Biological Station	24	8	9
,, Postage, Carriage, &c.	2	9	1
,, Salary, Curator	75	0	0
,, ,, Assistant	27	6	0
,, Sundries	7	11	6
,, Balance in Bank	1	13	9
	£176	14	1

1904.	£	s.	d.
By Balance in Bank (Dec. 31st, 1903)	4	1	2
,, Subscriptions and Donations received	79	4	0
,, Amount received from Universities for hire of "Work Tables"	30	0	0
,, Dividend, British Workman's Public House Co., Ltd., Shares	6	8	9
,, Sale of Nat. Hist. Specimens	0	12	3
,, Interest on British Association (1896) Fund	38	1	8
,, Bank Interest	0	7	7
,, Laboratory and Class Fees	8	19	0
,, Sale of Guides	8	1	3
,, Sale of Bottles, &c.	0	18	5
	£176	14	1

Endowment Invested Fund:—
British Workman's Public House Co.'s shares £173 1 0

EDWIN THOMPSON

ACTING HON. TREASURER.

LIVERPOOL, *December 31st, 1904.*

Audited and found correct,

A. T. SMITH.

Illustrated Notes

on

Manks Antiquities

P. M. C. KERMODE & W. A. HERDMAN
F.S.A., Scot. D.Sc., F.R.S.

LIVERPOOL
1904

E


ISLE OF MAN
English Miles
IRISH SEA
IRISH SEA
Point of Ayre
Ramsey Bay
RAMSEY
Andreas
Jurby
Kirkmichael
PEEL
GERMAN
Douglas Bay
Douglas Head
Laxey Bay
Laxey Head
Calf of Man
Spanish Hd
Niarbyl Bay
Port Erin Bay
Bradda Head
Castletown Bay
Langness Pt
Dreswick Pt
Contrary Hd
Peel Bay
Onchan
Clay Head
Port Cornah
Bulgham B.
Tableland Pt
Maughold Hd
Point Cranstal
Rue Pt
The Ayre
Jurby Hd
Glen Moor
Lady Port
Dalby Pt
Santon
St Michael's I
Scarlet Pt
Port Soderick
Port Groudle
Garwick Bay
Laxey
Sulby
Ballaugh
MICHAEL
GARFF
MAROWN
RUSHEN
MALEW
ANDREAS
AYRE

Fig. 1.

PREFACE.

On a prominent shoulder of the Meayll Hill, overlooking Port Erin Bay and facing Bradda Head, stands one of the most remarkable monuments of antiquity—a circle of stone cists of late Neolithic or early Bronze age, so curious in the arrangement of its parts that it appears to be unique in the British Islands, and is probably only paralleled, but scarcely equalled, by certain burial mounds in Scandinavia.

Some twelve years ago, recognising the important nature of this relic of prehistoric times, and struck with the incorrectness or inadequacy of the brief references made to it in archæological works, we devoted some time and trouble to a systematic examination of the site, and published a pamphlet, in December, 1893, giving an account of our excavations, with illustrative plates. A couple of years later we made an exploration of the ancient hut village that lies in the "Hollow of Botheration" (Lag ny Boirey) further down the hill; and after the Liverpool meeting of the British Association in September, 1896, we took a party of distinguished archæologists—Prof. Montelius, Dr. Munro, Prof. Haddon and others—to see the results of our labours. Parts of the excavations were still open, and the curious symmetry in the arrangement of the stones excited considerable interest, and some discussion as to probable age and the relationship to other megalithic monuments elsewhere. The importance of the Manks prehistoric remains in relation to Scandinavian antiquities was obvious during

the four or five days that our friends were able to devote to a rapid survey of the Island; and we were pressed then, and on many occasions since, to extend our observations to other parts of the ground and to earlier and later traces of human life and work.

The pamphlet on the Meayll stone circle has been long out of print and is often asked for, the single copy at the Port Erin Biological Station is frequently borrowed by students working at the Institution, and the Curator—Mr. Chadwick—informs us that from the applications made to him by visitors it is clear that if the work were reprinted there would be a considerable demand for it.

As we have for some years taken every opportunity that offered of exploring the antiquities of the Island, and as a considerable accumulation of unpublished notes and drawings is now in our hands, we have decided while reprinting our account of the stone circle on the Meayll, to let that monument now take its proper place in the series, and, by adding some description of the still earlier and the later prehistoric and eohistoric Manks remains, to form what we hope may prove a useful illustrated introduction to local archæology.

P. M. C. K.
W. A. H.

PORT ERIN,
December, 1904.

ILLUSTRATED NOTES

ON

MANKS ANTIQUITIES.

The Isle of Man is interesting from various points of view, and many of the more or less scientific summer visitors to its shores must often have found intellectual delights in its marine biology and its botany, in its rocks and fossils and in tracing the survival of ancient customs and the still earlier remains of prehistoric Man. The past history of the land and the people is so constantly and so prominently brought before the eye and the imagination by Tynwald Hill and Rushen Castle, by early Celtic and Scandinavian carvings, by ruined "keeils" and holy wells, by tumulus and standing stone, by cup-markings, archaic pottery and fields of chipped flint, leading back to the remains of extinct animals and the work of the great ice-age, that the observer naturally desires some guide which will enable him to place and classify, however imperfectly, these ancient records from the soil and the rocks. Although these unwritten records may not enable us to form anything approaching a complete and satisfying history, they yield welcome glimpses into the past state of our land, and show us something of the habits of races that have contributed to our ancestry.

Archæology traced back to its beginnings merges into Geology; and we find on examination that the Isle of Man has been a land-mass since very early geological times. The precise age of the oldest stratified rocks

forming the foundation of the island is very difficult to determine owing to the absence of undoubted fossil remains and the alterations due to heat, pressure and earth movements. The "Manx slates" which build up its backbone from Bradda Head to North Barrule (fig. 1, Map) are however certainly not later than Lower Silurian, and are placed by Mr. Lamplugh in his recent Memoir* as Upper Cambrian, with a query; and this central ridge which constitutes the mountain ranges seems to have been an insulated mass even as early as the beginning of the Carboniferous period. "This prototype of the present island appears afterwards to have been enfolded and obliterated by the sediments of later times; but with the process of denudation the old ridge has once more emerged from beneath this mantle." The physical features of the district, such as are necessary for an understanding of the past history, can best be given by quoting a few paragraphs from Chapter I. of Mr. Lamplugh's authoritative Memoir, as follows:—

"Its insular character is as well maintained in its physical as in its geological features. The erosive agency of the simple drainage system descending radially to the sea from the central hill-range, together with that of the waves which surround it, is adequate to explain all the contours of its present surface. It must indeed frequently during its history have been re-united to the mainland by a continuous land surface; but at such times it probably still retained in some degree its characteristic individuality, and arose above the surrounding plain as a hilly tract with a self-contained drainage, although its streams may then have been tributary to a larger river-system lying beyond its limits."

* The Geology of the Isle of Man, by G. W. Lamplugh: Memoirs of the Geological Survey, 1903.

"The sketch map, fig. 2, will serve to recall the position of the Island as regards the neighbouring shores. Its northernmost point is 16 miles distant from the nearest headland of the Scottish coast, while its closest approach to the Cumberland shore is 31 miles, to that of Ireland in Co. Down 31 miles, and to the Welsh coast near Holyhead

FIG. 2.—Sketch Map and Section of the Irish Sea-Basin (Prof. W. A. Herdman, Report Brit. Assoc., 1896).

45 miles. The same map shows roughly the contours of the surrounding sea-bottom. To the eastward of the Island the depth is nowhere more than 20 fathoms, to the northward it rarely reaches 30 fathoms, to the southward it

usually ranges between 30 and 50 fathoms, while to the westward midway to the Irish coast there is a long narrow trough descending to over 70 fathoms."

"As at present constituted, the Island, with the detached islet of The Calf off its south-western extremity, contains 227 square miles (140,325 acres), of which 170 square miles, or three-fourths of the whole, are occupied by the slate and greywacke rocks, probably of Upper Cambrian age, composing the hilly massif. Strata of the Lower Carboniferous age occur in a small basin of 7 or 8 square miles at a low elevation in the South of the Island, and a narrow strip of red sandstone, probably belonging to the same period, borders the coast for two miles about midway upon the western side. The northern extremity consists of a low-lying tract of about 45 square miles, which is an addition made to the Island in glacial times by the deposition of great masses of glacial drift upon the pre-glacial sea-floor. Deep borings through this drift have recently revealed a rock-floor of Triassic, Permian, and Lower Carboniferous strata at a considerable depth below sea-level."

"The Island is irregularly oblong in shape, with its longer axis running N.N.E. to S.S.W., which is the direction of strike of the slate rocks. In this direction, from the Point of Ayre to Spanish Head, the land has a length of 30 miles, while the breadth of its wider central portion varies from 8 to 12 miles. Excepting in the well-cultivated northern plain there is little flat ground. In the interior the physical features bear much resemblance to the southern uplands of Scotland. The hills are steep, but not generally craggy, and are arranged in long grassy or heather-covered ridges running with the longer axis of the Island, with broad intervening valleys. The highest of these ridges commences in the vicinity of the eastern

coast near Ramsey, and is practically continuous to the south-western coast north of Port Erin, but is broken across in one place by a deep transverse valley, which intersects the Island between Peel and Douglas. North Barrule, with an altitude of 1,840 feet, forms the north-eastern extremity of this ridge, which culminates $3\frac{1}{2}$ miles farther south-westward in Snaefell, the highest point of the Island, with an elevation of 2,034 feet, while Cronk-ny-Arrey-Lhaa overhanging the south-western coast, is 1,449 feet in height."

"Most of the larger streams of the Island rise in the vicinity of Snaefell and fall outward in different directions to the sea, the Sulby river and Glen Aldyn water draining northward, the Corna and the Laxey rivers eastward, the Glass and the Baldwin south-eastward, and the Neb south-westward. The drainage of the smaller tract south of the transverse valley is radial from a separate centre in the south-western portion of the hill-chain, whence flow the Glen Rushen waters north and north-westward, the Foxdale river northward, and the Santon, the Silverburn, and the Colby southward."

During the Great Ice Age which terminated geological as distinguished from recent times the Island was buried under the mass of conjoined glaciers which filled up the basin of the Irish Sea. In post-glacial times, as the ice-sheet retreated from North-western Europe it left the configuration of the Island much as we see it at the present day.* Its main valleys were in existence long before that period; its hills were doubtless somewhat higher, the volume of water in the streams was greater, and there were lakes of some size, especially in the North, where the broken remains of a large body of water, formed

* See Map, fig. 1, on back of title-page.

as the ice retreated from the high hills to the coast, continued on into historic times in a reduced state so as to be mapped in 1595 by Thomas Durham, and by Chaloner in 1656. A former lakelet is shown also near Castletown draining into the sea at Poyll-vaaish.

In later post-glacial times this land was covered in great part with forests, particularly of oak, fir, and hazel, the remains of which, off Strandhall and Mount Gawne in the South, may be traced below the present tide-mark, and are of very special interest to us as having possibly been still in existence when Man first made his appearance in our island. For Cumming states* that he had "a celt of the simplest kind, found under the peat on the edge of the curragh near East Nappin. In a meadow adjoining Close Mooar, the property of Professor E. Forbes, were found a short time ago a stone axe and sharpening or edge stone, a few feet asunder. They lay upon a bed of fine sand, covered with a stratum about four feet thick of peat—trunks of oak trees, &c., and over the peat was a bed of blue alluvial clay to the depth of three or four feet." In the same work (p. 139), he mentions it as "singular that an oak tree removed from this submerged forest exhibited upon its upper surface the marks of a hatchet"; and further adds, at second hand, that "the foundations of a primitive hut were laid bare, and that therein were some antique uncouth-looking instruments, once the property it may be of the primitive wood-cutters." Again Mr. Jeffcott, High Bailiff of Castletown, recorded† his discovery at Strandhall, where pieces of the antlers of the Irish elk had shortly before been found, of "fragments of human skulls and other human bones" in the débris of a deep excavation in the sea-beach made by

* The Isle of Man, by J. G. Cumming (1848), p. 216, footnote.

† Yn Lioar Manninagh, Vol. I., p. 56.

floods. These were associated with a jaw-bone believed by Professor Busk to have been that of a red deer.

Measured in years, the formation of these forests and peat beds must have spread over a very long period—a time of gradual upheaval by no means confined to this small area, but part of a general movement, to be afterwards followed by a depression of the land throughout Great Britain and Ireland, which carried the ancient forests down in some places to below the present sea-level.

The 10-fathom line around our coast has been considered to be roughly the boundary of the land at the time of greatest elevation. This forest growth has been shown to belong to the Neolithic, or later stone age, by the presence of animals first domesticated, and introduced to our country by Neolithic man, as well as by the absence of the extinct mammalia characteristic of the previous periods. The climate would be necessarily affected by the enlarged area of land, the extended water-system and the growth of forests, and must have been generally more damp, with greater extremes between summer heat and winter cold. It was probably a good deal more favourable to the formation of peat-beds than the conditions seen at the present day.* Associated with the silt at the bottom of these peat-beds we have records of the Great Deer usually known as the "Irish Elk," *Cervus giganteus* (formerly called *Megaceros hibernicus*), a noble animal (see fig. 3) with a spread of antlers extending to over 9 feet.

* There is reason to believe that during historic times, since the disappearance of the ancient Neolithic forests, trees have been few and of scanty growth over the greater part of the island. Thus, Chaloner (1656) referring to the former plenty as seen in the bog-oak, &c., speaks of the Island as "now destitute of Wood, and of the Plantations which *some few* have made about their houses" (Manx Soc., Vol. X., p. 8). In this connection Dr. Harold Bailey, of Port Erin, has pointed out that there are remarkably few wood-feeding beetles in the island, and that even these may have been introduced of recent years with timber from the main land.

The coming of this huge land animal to our island takes us back to still earlier times, but does not necessarily imply any land connection with neighbouring countries.

The glacial conditions which during the Ice Age overwhelmed the Isle of Man doubtless exterminated all previous forms of life—both plant and animal. Consequently after the emergence of the higher part of the island from the waning ice-sheet both fauna and flora must have been re-introduced from the adjoining lands and ultimately from the Continent of Europe. It was about this time that it is supposed that the Irish Elk may have crossed the retreating and melting ice-fields to reach the possibly verdant hills of Man, just as its near relation the Reindeer is known to traverse the frozen sea north of Siberia, crossing from island to island by ice.*

Remains of the Irish Elk have now been dug up at several different localities in the Island, as at Balla Lheaney, Andreas; Ballaterson, Ballaugh; Close-y-garey, near St. John's; and Strandhall and Kentraugh in the South. Besides Mr. Jeffcott's instance quoted above, Cumming mentions† the finding of an axe "with the remains of this animal." Further search may produce still more satisfactory evidence that the elk survived to the period of these peats and forests, and so became a contemporary of our earliest inhabitants of Man.

If so, not only would it form a connecting link between man and the glacial period in this area, but it is of special interest in that "it is the sole survivor from the Pleistocene into the Prehistoric age, which has since

* On the other hand, Lomas (Proc. Liverpool Geol. Soc., 1903-4) believes that on the melting of the Irish Sea glacier a low undulating land connection existed between the Island and Lancashire; and that following the advance of vegetation the Irish Elk may have crossed by means of this lost land.

† Arch. Camb. XI., 3rd Series, p. 429.

become extinct."* A fine example from Close-y-garey, a boggy depression by the north side of the railroad, just half-way between St. John's and Poortown, recovered in 1897 with the co-operation of a Committee appointed by the British Association,† may be seen in the Insular Museum now temporarily located in Castle Rushen (see fig. 3).

These elk remains, where exact details of the sections or layers shown in the excavation are known, have always been obtained "from the lowermost portion of the alluvial deposits, and from beds which contain the first indications of organic life after the emergence of the land from under the ice-sheet," and Lamplugh suggests (Memoir, p. 388) that the elk was an early post-glacial inhabitant and may have reached this island, and even Ireland, across ice-fields when a remnant of the great glacier still occupied the basin of the Irish Sea; and may possibly never have been a permanent resident but only a migratory visitor. "The animal," he adds, "may have lingered on into the age of forests, when the principal peat-bogs of the Island were accumulated, but for this there is at present no positive evidence."

The depression of the land referred to above was followed again by a gradual elevation which Cumming supposes to have continued to the present day, but Lamplugh argues on the contrary that it has in its turn been followed by yet another slight depression. Traces of the last upheaval are marked all round the Island by a well-worn notch on the cliffs and by raised beaches at a height of 10 or 12 feet above present high-water mark. That these beaches, which are later than the forest period, were already formed, or being formed, while the Island

* See Boyd Dawkins' Early Man in Britain, p. 247, and 257.
† British Assoc. Report for 1898 (Bristol) pp. 548-551.

FIG. 3.—Skeleton of Irish Elk from Close-y-garey, St. John's. From a photograph by Mr. G. B. Cowen.

was inhabited by Neolithic man, Lamplugh considers proved by his discovery of worked flints on their surfaces, "some struck into flakes on the spot." Dr. Munro has stated* that the upheaval which caused the similar 25 foot raised beaches in Scotland was completed about the beginning of the bronze age.

It was shown during the second quarter of the nineteenth century, mainly as a result of the labours of the Scandinavian archæologists Thomsen, Nilssen and Worsaae, that a scientific division of prehistoric times in Northern Europe could be made into the three ages of "Stone," "Bronze" and "Iron." Further study of the earliest prehistoric remains, especially in France and England, has led to the recognition by archæologists generally of an older and ruder as distinct from a later stone period, giving us in all the four divisions:—Palæolithic, Neolithic, Bronze and Iron. These successive periods of advancing civilisation bridge the interval between geological and historic times, and a few sentences about the general characteristics of each age may be given before we pass to our notes on the Manks antiquities.

We may recall that at the close of the Tertiary Geological period, in Pleistocene times, Europe as far South as 50° north latitude was covered with a great ice-sheet largely consisting of glaciers which descended the valleys, crept down upon the plains, and even ground their way along the floor of the ocean. Scattered boulders, beds of boulder clay and heaps and ridges of stone, gravel and sand (moraines) are found deposited in various parts of our country as remains of this "ice-age." Man was certainly in Europe and possibly even in Britain, which was then united to the Continent by continuous dry land,

* Proc. Roy. Soc. Edinb., Vol. XXV., p. 272.

before the ice-age; but no remains of that earliest inhabitant have yet been found in the Isle of Man. The so-called "River-drift" man has only left his remains in the South and South-east of England up to about a line drawn from the mouth of the Severn to the Wash, while the rather later "Cave" men extended further up to the North of Yorkshire. These were the men of the Palæolithic Age, when the use of metals was not known and the stone implements were rude and unpolished. These primitive weapons, tools and other remains are found in association with the bones of long extinct animals characteristic of the Pleistocene period, such as the mammoth, the cave bear and cave lion, the bison, a hyæna, and the woolly-haired rhinoceros. No traces of the presence of man at this early period or of any of such extinct mammals have, however, been found in our district.

As Great Britain became severed from the Continent before the next race of men, those of the Neolithic Age, spread over the country these must have arrived by sea; and as Man has been an island since even earlier times the successive waves of immigration which swept across from East to West must all have reached our shores by boat—unless, as Lomas has suggested, the sandy coast of North Lancashire may possibly have extended in prehistoric times by way of the Bahama banks to the Point of Ayre.

The Neolithic or later Stone Age man was of that non-Aryan pre-Celtic race which is usually called Ivernian or Iberian, and is supposed to be related to the Basques of the South of France and Spain. It is doubtful whether Palæolithic man has left any descendants in our islands, but there is probably a considerable amount of Neolithic blood in the western parts of Britain. Man of the later Stone Age, when the next wave of immigration

arrived, was no doubt driven back, but was probably assimilated rather than exterminated by the Celtic invaders from the East, who brought with them a knowledge of working in copper and inaugurated the age of bronze. The characteristic weapons and implements of the Neolithic Age are made of flint and other hard stone, usually finely chipped and ground at the edges, and sometimes polished with a beautiful finish. Most of the implements, however, were not polished, and the axe-heads are rarely perforated. The art of making pottery was known, spinning and weaving were practised, and all our common farm animals were domesticated.

Neolithic man in this country was small, averaging, it is calculated from the bones, about 5 feet in height, and had a long narrow (dolichocephalic) skull. The type is thought to be still recognisable amongst the smaller, dark Manks people; and the worship of "holy" wells, and the reverence for the tumulus and the standing stones may be regarded as a survival from these far back pre-Aryan times.

There seems reason to believe that the use of copper spread in late Neolithic times from Cyprus along the shores of the Mediterranean to Western Europe; but the coming of copper and bronze to Britain is usually associated with invasion of the country by an Aryan race, the Celts, who were taller than the Neolithic inhabitants, and had rounded (brachycephalic) skulls. The finest types of polished stone implements were made in this age along with the bronze weapons and tools that characterised it.

The Celtic tribes that invaded the West of Europe at the end of the later Stone Age have been divided into an earlier "Goidelic" (the Gaedhils of Ireland, Scotland and the Isle of Man) and a later "Brythonic" wave, separated possibly by centuries. The Goidels probably absorbed

more of the blood of their non-Aryan predecessors and gave rise to those northerly and western Celtic nations that speak a Gaelic tongue; while the later Brythons became the more southerly peoples of Wales, Cornwall and Brittany. The Celtic element in the Isle of Man is Goidelic, and that with its Neolithic strain forms the basis of the Manks people, reinforced later on by a strong Scandinavian influence.

For the bearing of the local folklore upon prehistoric questions, the reader should refer to Mr. A. W. Moore's book, "Folklore of the Isle of Man"; but we may briefly state here that the many stories of encounters between mortals and fairies or gnomes inhabiting the caves or the earth between men with swords and demons with magic spells are supposed to be the relics of traditions handed down as to the real struggles between the invading Celts with bronze weapons and the pre-Aryan Neolithic inhabitants. There is some evidence, given by Moore and others, that the conquering Goidelic Celts were "impressed by the nature worship of their predecessors, and feared them as being gifted with magic powers." So, we are told, Mannanan Mac Lir, the non-Aryan magician, "kept by necromancy the Land of Mann under mists"; and, when routed by St. Patrick, according to the Manks legends, he and his people being of small stature "became fairies and lived in the ancient tumuli, using flint arrow heads as the weapons with which they avenged their wrongs on human beings."*

The fourth or Iron Age was a late Celtic period which extends into historic times. Just as stone weapons were still in common use during the Bronze Age, so we find the iron and bronze periods overlapping in their turn. These are facts of importance which must be borne in mind when

* Moore, History of the Isle of Man, p. 43.

discussing loose implements not associated with surroundings which clearly determine their period.

The majority of the prehistoric remains in the Isle of Man belong to the Neolithic and the Bronze periods, and it may well have been that in this remote and limited area these stages of civilisation may have each persisted on to later times than in other parts of Europe. It is impossible to assign dates for such "ages" in our district, but it may be of interest to note that the Neolithic period is said by Reinach to have extended at Crete from 4500 to 2800 B.C. It probably continued much later in our Western Isles. The knowledge of copper and bronze is supposed to have reached Crete about 2800 B.C., and in France Montelius estimates that the Bronze Age commenced in 2000 and ended about 850 B.C.

The earliest traces of man met with in our district show him to have been then in the Neolithic stage of civilisation.

Structural remains of the period are difficult to identify at first sight, and can only be determined with certainty by careful excavation and examination. They consist of habitations, camps or forts, and burial places. We have also examples of "Neolithic floors or platforms," that is to say, areas of the ancient surface where flint implements of many kinds have been actually manufactured. At the West Craig and the Lagagh in Andreas, at Cass-ny-Hawin, near Ronaldsway, at Ballakaighan, German, and at Port St. Mary, have been found great accumulations of cores, chips, and worked flints of very primitive type.

On the brooghs overlooking Ramsey Mooragh, building operations about 20 years ago disclosed an area, at a depth of from four to six feet below the surface, which was strewn with flint cores from which implements had been

made, chips struck off in their fabrication, flakes, knives, scrapers* of at least three forms, drills or awls, arrow-heads, and a few stone hammers, with great numbers of broken fragments.† All the implements were small, for the most part very rudely formed, though some were rather more finely finished (see fig. 4).

Fig. 4.—Types of Neolithic flint implements.

Three burial places were met with in this area, with fragments of decomposed bones in rude cists; also broken pottery, ashes with traces of calcined and decomposed

* In regard to the separation of stone implements into axes, celts, lances, knives, scrapers, awls, &c., it is important to note that Dr. W. E. Roth, writing on the Ethnography of Queensland, says that the modern savage certainly does not recognise these fine distinctions.

In the case of the earlier and ruder forms at least it may well have been that the shape of the detached or chosen fragment was more or less accidental, and it was probably used indifferently for various purposes as was found convenient.

† Yn Lioar Manninagh, I., 2, 90, 131, 212.

bone. Some of these remains may possibly have been of Bronze Age, the platform having been apparently occupied for a lengthy period.* No token of village life was discovered, and the place may have served only as a temporary camping ground from time to time.

A somewhat similar floor was discovered in 1899 by the Rev. J. Quine on the left bank of Glen Wyllin, Michael. Great numbers of flint implements have been found here—flakes, scrapers, awls, arrow tips; also hammer-stones showing signs of use, and differing somewhat in type from those at Ramsey. Though no hearth-stones nor hut foundations have been met with, the presence of "fire-holes" would seem to show signs of habitation.

At Rhewyllin, Port St. Mary, Mr. F. Swinnerton discovered another Neolithic floor in 1900, with abundance of shells, decayed human bones, broken hammers, implements of quartz, flint, and slate; arrows, flakes, chips and scrapers.† At the base of the Alfred Pier, Port St. Mary, Mr. Swinnerton had previously found similar remains of a camping ground during the excavations made in forming the roadway. Here he met with decomposed human bones and teeth, bones of rabbit or hare; limpet, periwinkle and dog-whelk shells; a flint arrow-head, scrapers, flakes, and awls, besides some fragments of pottery which he took to be remains of cooking vessels. On this floor were several cists formed of large slabs set on edge, capped originally by a covering stone, typical examples of Neolithic burials (fig. 5).

Though the "floors" referred to show no traces of habitations, we have in places examples of "Hut-circles," or the foundations of primitive dwellings, similar to those met with elsewhere and identified as belonging to this

* Yn Lioar Manninagh, I., 2, 262. † Yn Lioar Manninagh, III., 635.

period. A single one of them is clearly traceable in the middle of the high road at Ballaquane, near Dalby. The largest and most interesting collection of such remains is that around the Meayll Hill, near Port Erin, where there are three or four clusters all on a level round the hill with the old village of Cregneash, which it is possible may have been another kept in continuous existence ever since Neolithic or Bronze times. These huts from their contents are evidently in association with the Meayll burial place, a curious circle of cists placed higher up on the same hill, to be described further on. It must be noted, however, that the huts were apparently occupied up to a much later

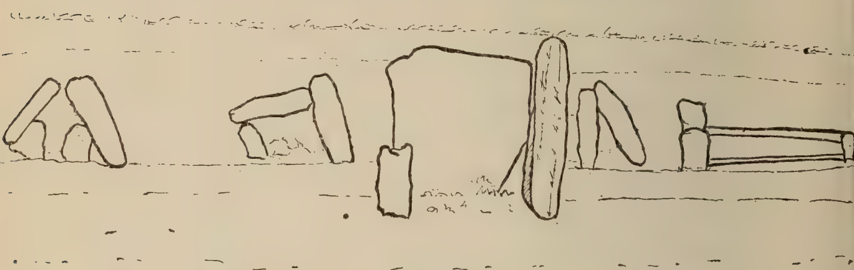


FIG. 5.—Neolithic cists, Port St. Mary. Sketch by F. Swinnerton.

date than that of the stone circle, and, if Neolithic in origin, must belong to the close of that period, which doubtless persisted much later in the Isle of Man than in Britain generally.

Not far away, on the opposite mountain, at a hollow (known as the Sloc) in the Carnanes on the slope of Cronk-ny-Irree-Laa, is another collection of hut-circles, among which a few worked flints have been found.

In one or two places, as at the foot of Snaefell and at Ballakaighan, German, indications have been met with of pile-structures, reminding one of Boyd Dawkins' description of a log house in Ireland, surrounded by a staked

enclosure.* At Ballakaighan these remains were found in association with a bog-oak canoe, hollowed out of a tree trunk; the space around being thickly strewn with rude flint implements, burnt stones, and ashes. (See figs. 7 and 8).

The earth and rubble foundations of numerous camps and small forts are met with around the coast, on craggy rocks in glens, and on hillsides, some of which date from this early period, though no doubt they may have been occupied also much more recently. For example, a small peninsular earthwork at Gob-y-Garvane on the rocky Maughold coast; one on the broogh at Cass-ny-hawin, Santon; Hango Broogh, on a rocky projection between St. Michael's isle and Langness, Malew; and the two Boirranes near Dalby, are instances of coast defences which may have originated in Neolithic times. The earthwork within Peel Castle also, about which have been found many worked flints and a small stone axe, is likely to have been in use from the earliest times, but, neither in this nor the others is there any real indication of date, beyond the small size, the simple plan, and the presence in their immediate neighbourhood of worked flints. Inland, a good example may be seen on an isolated rock at Cashtal Ward, Tromode, and at Ballanicholas, Marown. On hill-sides are remains at Ballakilpheric, Rushen, and one on the summit of the curious isolated hill at the entrance to Sulby Glen known as Knock-Sumark.

Finally, we have burials of Neolithic age. In that at Port St. Mary already referred to (fig. 5) were several cists formed of large slabs set on edge, capped originally by a covering stone. On the floors were found crumbling human bones and teeth, flint flakes and implements. Opposite Tynwald Hill, on the Follagh-y-Vannin road, a

* See Early Man in Britain, p. 288.

mound has been cut through, exposing the side and end of a fine stone cist; the hill, or cronk, about 5 feet high and 45 by 60 in diameter, shows in section a layer of rather large, water-worn, white quartz stones over the cist, of which the inside dimensions were 5ft. by 2ft. 7in., and 2ft. 10in. high. It had been paved with smaller rounded white pebbles, from 2in. to 3in. diameter. The bones had crumbled almost to dust. A flint core was met with in the cist, and a rude scraper in the mound above it.*

There are many small tumuli scattered all over the Island. Whether these are Neolithic, Bronze, or even later, cannot be determined from their exterior; and, while some probably belong to this earlier period, the greater number of them which have been examined are shown by their contents to be of the succeeding or Bronze Age. The main distinction lies in the fact that Neolithic burials were by inhumation, the body being seated or doubled up in a cist formed of large slabs of local stone, while in the Bronze period cremation became usual and the incinerated bones were gathered into urns of baked clay, often decorated with characteristic patterns, or, in some cases, were placed in small chambers of slaty stone, different in size and character from the cist of the earlier period. A stone circle on Ballakelly, Santon, may be Neolithic. It consisted of a double circle of large stones of the local Santon granite, set on edge, of which enough remains to show the original plan; in the centre is a cist also of heavy stones on edge—one of the stones of the inner ring is ornamented in one corner by rows of small cup-hollows.† A somewhat similar stone circle with central cist is to be seen on Kerroogarrow, German.

In connection with these burials may be mentioned

* Yn Lioar Manninagh, III., 373,

† Manx Society, Vol. XV. p. 98, and plates.

the Menhirs or Standing Stones, some of which appear to be sepulchral monuments of Neolithic Age. In one case, where two such stones may still be seen, at Ballakilpheric, Rushen, two others are known to have been near them in such a position as to suggest that they formed the remains of a large circle. Worked flints and some rude pottery have been found near by. At Port St. Mary, the "Giant's Casting Stones," close to which worked flints have been found, may perhaps have stood singly. At Glen Mooar, Michael, near the Spooyt-vane, and just above the rail-road, is an unhewn stone pillar or Menhir set upright on a little craig facing the sea. At its foot are some cup-hollows cut in the out-cropping rock, and, a little below, on the face of the crag, are larger shallow, basin-like hollows (fig. 6). In some instances such cup-marks appear to have been intended to hold offerings to the dead.*

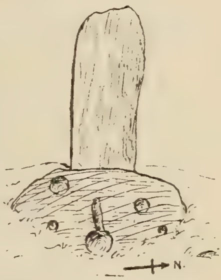


FIG. 6.—Standing stone and cup-marked rock at Michael—from a sketch by P.M.C.K.

Loose objects belonging to the Neolithic period have been found in all parts of the Island, and frequently in or near the monuments already described. Implements of flint are in especial abundance; besides cores and chips, we meet with flakes, knives, and scrapers of three or four different types, drills or awls, arrow-, javelin-, and spear-heads, and celts or axe-heads. A characteristic of the flints is their rudeness and simplicity of make, combined

* The *Times* correspondent "With the Mission to Tibet," August 11th, 1904, describing the Ling-kor, or sacred way, with the 20,000 images of Buddha, refers to "probably the largest 'cup-mark' in the world. There is a smooth worn hole 3ft. or 4ft. deep and 5ft. in length, into which the pious either throw or from which they take away a pebble. The dust at the bottom is of great sanctity, and is much used for charms, and even as an ingredient of the Tibetan pharmacopœia."—(*Times*, August 19th, 1904.)

with their small size. The latter is no doubt due to the fact that flint is only found in the Isle of Man in the form of small nodules washed out of the boulder-clay, and it is noticeable that all the Neolithic floors known are on actual deposits of boulder-clay, so as to be close to where the flints naturally occur.

A very few implements of similar character to those mentioned above have been found formed of quartzite, and even of slate.

Of other materials are some almost unworked pounders, crushers, or hammer-stones, whetstones for grinding and polishing implements, and perhaps some of the spindle-whorls occasionally met with. The polished stone weapons, hammers and axes, or celts, are probably all of foreign make, as shown by the material, such as ophic-calcite, of which they are composed, and which is not found here *in situ*. It is moreover impossible to say with certainty whether such implements reached these parts in the Stone Age or later, for bronze being at all times much more costly and rare, stone no doubt continued long in use, so as to cause considerable overlapping of the periods.

Although some of the more primitive coarse, heavy, and unornamented examples of pottery, not turned by wheel, which have been exposed by agricultural operations, may have belonged to food vessels of this period, it is difficult to discriminate them from those of a later date, and our opinion must be guided by their surroundings and associations.

One or two small and very rudely formed dug-out canoes (fig. 7) seem to belong to this period. The one now in Castle Rushen was found at Tosaby, St. Marks. The most perfect example met with is that found in 1884, at Ballakaighan, German (figs. 7 and 8). It measured just

over 14 feet, having at one end 2ft. 3in., and at the other 1ft. 11in. of solid timber; the inside width is about 2ft., tapering to 16in.; the highest part is just 14in., and, inside, 10in. In the thick end a hole is pierced, perhaps for passing a thong or rope of hide through. Many such canoes have been found along the margin of the Clyde about Glasgow, some from "a single oak stem, hollowed out by blunt tools, probably stone axes, aided by the action of fire; a few cut beautifully smooth, evidently with metallic tools. . . . Those most roughly hewn may be relics of the Stone period; those more smoothly cut of the Bronze Age."*

Fig. 7.

The Ballakaighan canoe rested by the south side of a considerable area—about 60 feet by 9 feet, and 5 feet in deepest part—of burnt soil, stones and charcoal. Alongside, south of the canoe, at a lower level, was a row of flat stones resting on the soil and forming the edge of two cists, the smaller of which was uncovered, but the other capped by a slab of hard trap rock, 5ft. 6in. by 2ft. 6in. Beneath this, for a depth of 2 feet, was loose soil with twigs and nuts of hazel; at the bottom, blue clay with broken quartz on the surface. The smaller cist, also filled with loose soil, was divided from the other by a large flat stone set on edge; its more southern wall, however, was built of flat stones in four layers, and this was con-

* Glasgow Archæological Society, Vol. II., p. 46.

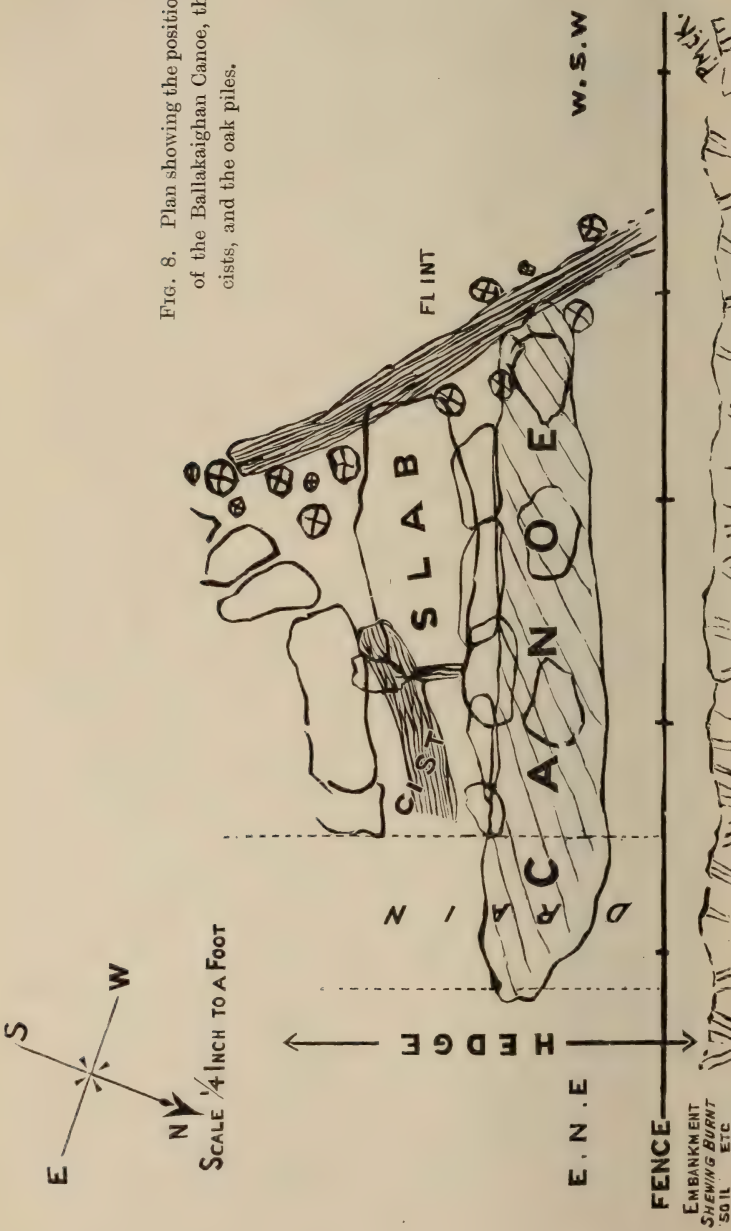


Fig. 8. Plan showing the position of the Ballakaighan Canoe, the cists, and the oak piles.

tinued in a curve westward and southward. Two large pieces of oak lay horizontally about 2ft. 6in. below the surface: one, which crossed close by the W.S.W. end of the canoe, lay diagonally with it about S.E. to N.W., and measured 8½ft. by 10in. diameter at its widest. The other, almost at right angles to this, its S.W. end about 4ft. off, passed diagonally beneath the smaller cist. Thirteen piles of oak were disclosed, the broken tops of which were about level with the bottom of the canoe. The largest measured 3ft. in length, of which about 18in. was formed into a point, very clean and smooth to have been done by an axe of stone; its diameter was 10in.

This was about 50 feet from the edge of the brooghs, and about 200 feet above sea-level. Inland, to the S.W., further traces of burning have been found, and more oak piles, while throughout the field great numbers of flint flakes and cores have been picked up.*

The transition from the Neolithic to the Bronze stage of culture must have been gradual in the Isle of Man. That the earlier people were not exterminated by these first Aryan invaders is evident from the fact that the small Iberian type may still be recognised in the Manks folk of to-day; as also may the taller round-headed type of the Bronze Age man.

Evidences of the transitional stage are to be seen in some sepulchral monuments of intermediate type, such as "King Orry's Grave," Laxey; a cairn at Ballagorry, Dhoon, Maughold; a passage grave at Kew, German: perhaps the circle on the Braid, near Sliean Chiarn, Marown; and one or two more. One of the most curious and interesting of these is the circle of cists on the Meayll Hill, above Port Erin, and as we made a careful examina-

*Yn Lioar Manninagh, I., 36; part 2, 78.

tion of this some years ago† and as it is the demand for copies of our paper now long out of print that has caused us to write out the present notes, we shall re-print here with some slight alterations and corrections that former account published in 1893.

THE EXCAVATION OF THE STONE CIRCLE ON THE MEAYLL HILL.

At the south end of the Isle of Man, next to the Calf Island, is a group of low rounded hills which stand out rather prominently from being nearly completely separated off from the remainder of the land by the narrow neck of low-lying country which runs from Port Erin on the west to Port St. Mary on the east. This is the "Meayll" (pronounced "Mule," derived possibly from the Scandinavian "Muli," a muzzle or snout, or perhaps more likely from the Celtic "Meall," = a hill or rising ground of rounded shape; so "Meaull" in Galloway, and "Moyle" in Ireland), a district very well suited to be a stronghold in savage times as it is surrounded on three sides by lofty and precipitous sea cliffs extending from the formidable Spanish Head and the Chasms round by the Calf Sound to Port Erin, while on the fourth side is the low neck of land which was formerly submerged and after that for a long time was no doubt a swamp or morass. This commanding situation probably rendered it a favourable habitation in early times—possibly it was a last refuge in the Isle of Man of the preceltic race—and on the higher parts of the hills, still uncultivated, we can trace the lines of ancient boundary fences dividing the moorland into small plots, we can find the remains of at least

† Trans. Liverpool Biological Society, Vol. VIII., p. 159, Pl. X.-XII. Yn Lioar Manninagh, II., p. 117.

three prehistoric villages or clusters of huts, and near the highest summit, known as the Meayll Hill, is the remarkable stone circle we are about to describe, an ancient burial place probably common to the neighbouring villages (see fig. 9).

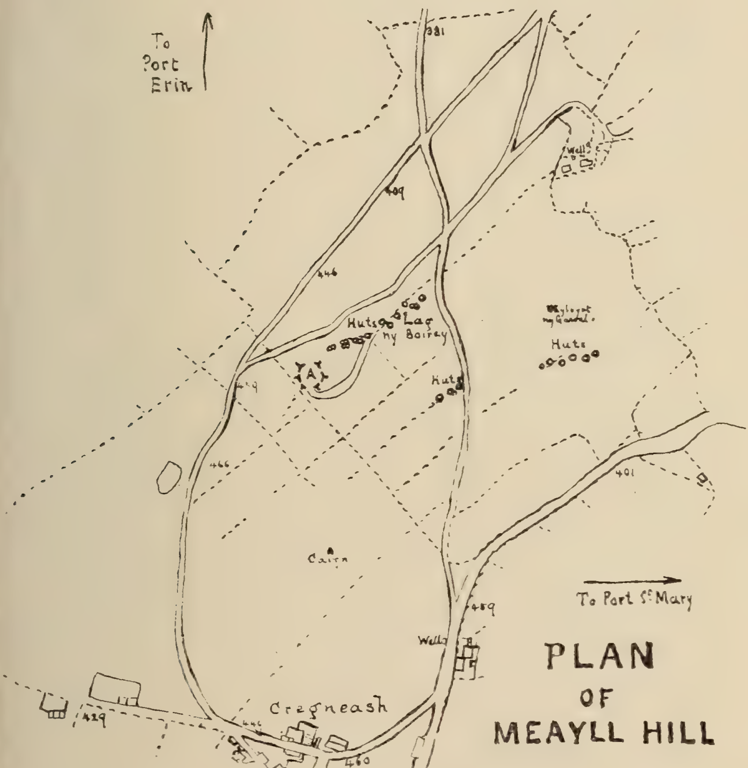


FIG. 9.

In form and arrangement this circle is we believe unique, and although it has long been known to local antiquaries, it has never, we consider, been adequately described or systematically explored. The late Mr. Jeffcott of Castletown gave an account of it to the

Cambrian Association in 1865, and this is quoted, and an imperfect figure given, by Fergusson in his "Rude Stone Monuments" (p. 158).

To this account, which is not quite accurate, he adds that from simple inspection it is evident that these cists must at one time have been covered with earth, and if so, thinks that so far as one example can go they would tend to prove that the circular vallum at Avebury and many other localities was a place for the deposit of bodies. He remarks upon the two gaps or openings in the circle opposite one another, as at Arbor Low and Penrith, but suggests that they may have arisen from the removal of cists. As the result of our examination we can state definitely that that is not the case—the openings were certainly left intentionally.

Finally, the Manks Archæological Commissioners in their report to Sir Henry Loch in 1878 catalogued this circle and recommended that a careful excavation should be made. This recommendation we endeavoured to carry out during August and September 1893, having first duly obtained permission from the proprietor; and although we found that some parts at least had evidently been formerly disturbed by irresponsible persons who have left no record—probably early diggers for treasure without any archæological knowledge or interest—still we unearthed a very perfect series of eighteen cists, and some remains of pottery and implements, and are now enabled to put on record a detailed description of this, one of the most interesting of ancient Manks monuments, and to draw more certain deductions as to its age and purpose.

Our general plan of the Meayll Hill (fig. 9), on the scale of about 6 inches to the mile, shows the position of the stone circle (A), the sites of the hut villages and the lines of the ancient boundaries.

Hut Villages.

Of the little villages referred to we have discovered the sites of three, containing each the foundations of 4 to 16 huts. The largest and most interesting of these groups (fig. 9) still retains amongst the country people its name "Lag-ny-Boirey," hollow of trouble, or lamentations, or strife, or, as the people put it, of "botheration."* When or why this name was given one can now only conjecture, but as it is good Manks, it seems to imply that the place was still known as an inhabited village within historic times.

This village lies about 330 yards N. of the cairn at the summit of the hill, and is immediately at the foot of the ridge on which the stone circle stands, in a sheltered hollow looking towards the north. The hut foundations of earthen banks and large unhewn stones are overgrown with heather and gorse, and lie in a straggling row along the eastern side of one of the ancient boundary fences; they extend over an area of about 130 yards, and are placed at distances apart of from 3 to 24 yards. In at least three instances there are groups of 2 or 3 huts adjoining, so that one wall would serve for two. One of these which we excavated measured inside 8 by 3 yards, and appeared to consist of two dwellings. The foundation stones were still in position and marked out a roughly rectangular building, with a division across the middle, having at the S.W. end what was probably an entrance passage 4 feet long by 3 feet wide, but partly built up like a step at the outer end. At a depth of about 18 inches we came on what was clearly the ancient floor with some charcoal

* When we laid an account of these excavations before the meeting of the British Association at Nottingham in September, 1893, Dr. Munro, President of Section H, suggested "scolding" as a better rendering of the word.

on it and fragments of pottery from $\frac{1}{8}$ to $\frac{3}{8}$ inch thick. The pottery evidently belonged to a crock-like vessel with a lip, and a reconstruction showed the mouth to have been about $4\frac{1}{2}$ inches across.

Another part of this village which we excavated proved to be a group of 4 huts varying in inside diameter from 6 feet to 12 feet 6 inches. The largest, of which the foundation stones all appeared to be in position, was rectangular and had an entrance about 3 feet square at the N.E. end; it was separated from the others by a wall 3 feet thick. A few small flat stones were found on part of the ancient floor, but nothing that was an undoubted hearth. In one of these huts was found a flint scraper, in another a small flint flake with two cutting edges. Perhaps a more remarkable find was a stone $5\frac{1}{2}$ inches by $1\frac{3}{4}$ inches by $\frac{3}{4}$ inch, of which one face was polished, having probably been used as a whetstone for polishing flint implements, or as a rubbing or polishing stone in curing and preparing skins. There were also found some small flints and quartz pebbles which may have been used for striking a light. Possibly the white quartz pebbles, a great number of which were also met with in the cists of the circle, had been used as "pot-boilers." If the rudely baked clay vessels were not able to stand much fire the contents may have been cooked by dropping in these stones previously heated on the hearth. This explanation may account for the small pebbles in the huts, but scarcely for the great numbers found in the graves (see below).

Somewhat further east than this village of "Lag-ny-Boirey" we found the circular foundations of 3 or 4 more huts measuring from 8 to 12 feet in diameter, and like the others these are on the line of one of the ancient fences (see fig. 9). Lower down the hill and still further to the east are half a dozen more such hut foundations. Their

outside diameters are from 4 to 5 yards, and the stones forming them—about 12 in a circle—measure about 4 feet by 2 feet and project about 2 feet above the surface; they are unhewn blocks of the same Manx slate of which the fences and the circle and the rock of the hill are composed. Like the other huts these are also on the line of one of the ancient fences and (also like the rest) occupy a sheltered situation looking to the north (*i.e.*, with an uninterrupted view across the lower ground to the remainder of the Isle of Man). This village has the further advantage of being just above the spring which is known as "Chibbyrt-ny-Garval," Horse-well.

One is tempted to suggest that we may have yet another of these ancient villages existing to this day in Cregneash, on the other slope of the hill, about 250 yards to the south of the cairn, and usually regarded as one of the very few typical old Manks villages left. Possibly some indication of this may yet be found by a careful examination of the gardens and bases of the cottages at Cregneash, but in the meantime it is interesting to note that Sir George Head writing in 1837 in his "Home Tour" (Vol. II, p. 23), speaks of a small hamlet near Spanish Head and between "Port-le-Murray" and "Port Irons" which must be Cregneash as "composed of edifices so rude, that it is really hard to predicate of the houses at a little distance, whether they are masses of rock or human dwellings."

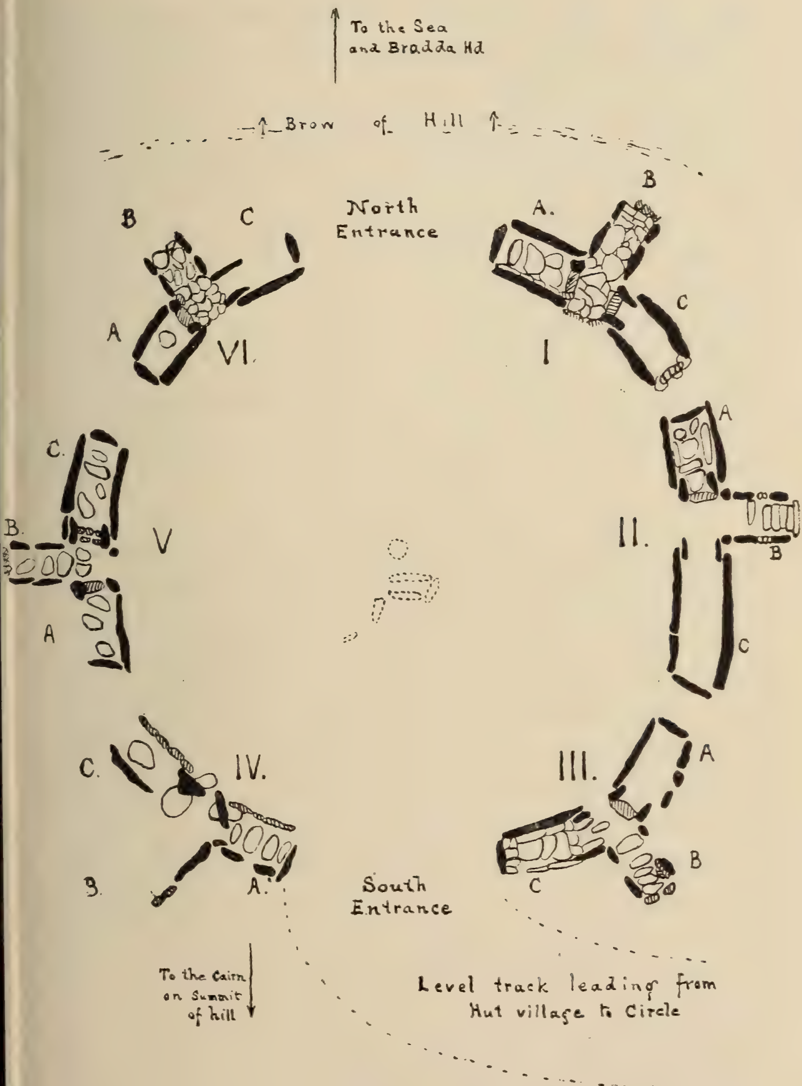
The Stone Circle.

The most interesting relic on the Meayll Hill is the stone circle which is situated a little way down from the summit at a distance from the cairn of 250 yards in a direction 10° W. of north, and at a height of about 500 feet above the sea. Mr. Jeffcott gives this burial place

the name of "Rhuillick-y-lagg-shliggagh," graveyard of broken slates. This name however we have ascertained belongs without doubt to the circle down at the Calf Sound a mile or so to the South, and we had no difficulty in discovering the true name of the Meayll Circle, for it is still in actual use among the fishermen, who take its prominent stones in a line with the Calf as a mark for one of their fishing grounds, and apply to it the name of the ancient village in the hollow immediately below (which of course is not visible from the sea), Lag-ny-Boirey, or hollow of botheration.

The circle (see fig. 10) is formed of six symmetrically arranged sets of cists or stone chambers, each set—for which we propose the term "tritaph"—being composed of one radial cist and two tangentially placed. Three tritaphs form the eastern half of the circle and three form the western, leaving considerable gaps or entrances at north and south. The south entrance measures 16 feet in a line with the external circumference, while the corresponding opening at the north is 18 feet across. The north to south diameter measures 50 feet, and the east to west 57 feet. A circular mound of loose stones and earth packed on to the external circumference of the cists slopes to 3 or 4 yards beyond the above measurements, and the whole may have formed a "disc-shaped Barrow," such as there appear to be traces of elsewhere in the Island.

There is some indication of a cist or chamber of some kind having formerly been in the centre, but it has evidently been previously disturbed and is no longer recognisable. Although there are slight differences in size and proportion between the different tritaphs they are all built on the same plan, viz., two large cists placed end to end running along the circumference of the circle, and one rather longer narrower one directed radially outwards



PLAN OF CIRCLE OF TRITAPHS.

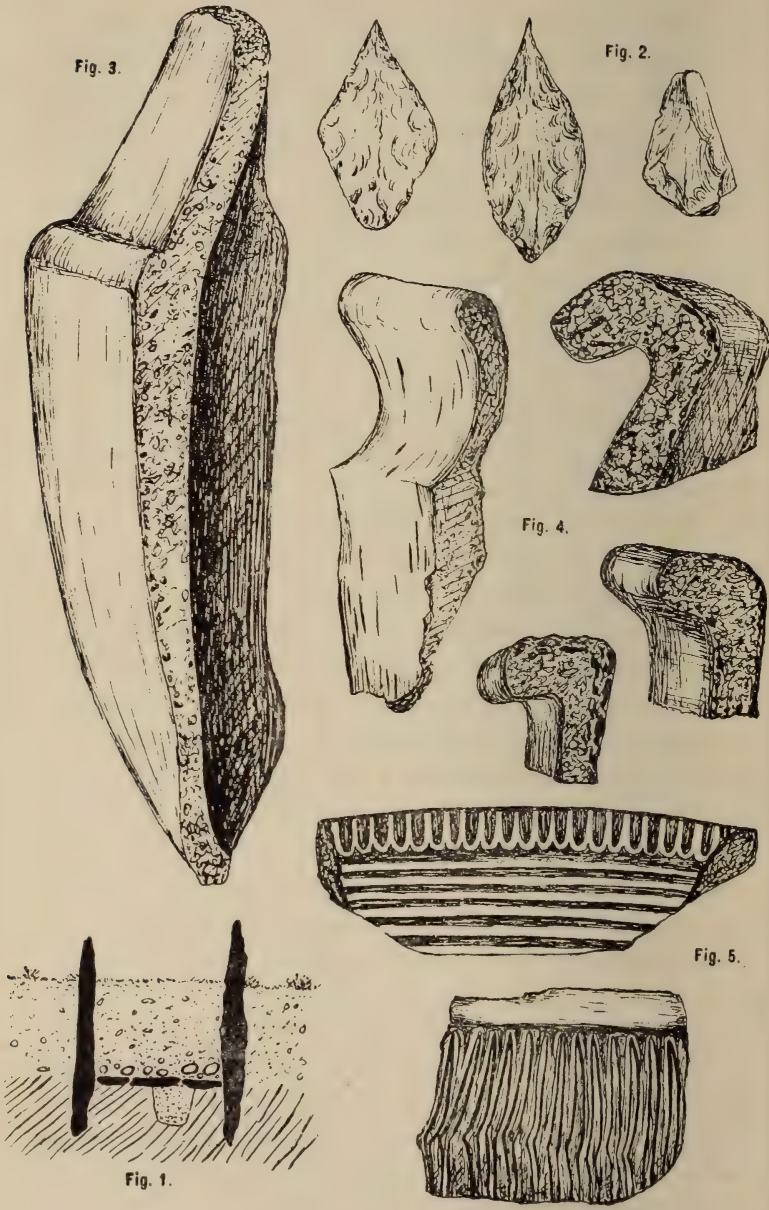
FIG. 10.

from the place of junction of the two former. The arrangement then is a triradiate one; we shall call the end of each cist which is nearest the common centre of the tritaph "proximal," the remoter end "distal." The tangential cists are composed each at the distal end of an outer end stone about 3 feet wide, of two side stones or monoliths placed on edge and measuring up to 8 feet in length, and of an entrance at the proximal end. This entrance consists of a pair of upright pillar stones one at each side, measuring 18 to 24 inches across, and standing within and partly overlapped by the large side stones. Sometimes at the base of the pillar stones and stretching between them is a flat slab, sill or step, and sometimes traces of a low wall built of smaller stones. In no case is this end closed by a single large end stone.

Between the proximal ends of these tangential cists and running out at right angles to them is the third or radial cist of the tritaph. It is formed of two pairs of small side stones each 1 to 2 feet across, and in all cases is open at its distal end where in some cases there are a few steps, formed of rough slabs, leading down from the surface of the ground to the floor. No gateway is present in the radial cists, which thus differ constantly in several points of structure—of sides, and of both ends—from the tangential cists. The average size of the tangential cist is 5ft. 9in. by 2ft. 8in., and of the radial cists 7ft. by 2ft. 3in. The floor, at a depth of 18 to 24 inches below the present surface, showed in all cases indications of a pavement of flat stones, on the average about 1 foot across and 1 to 2 inches thick. All these stones, from the large monoliths to the small gate posts and floor stones, are of the grey clay slate of which the mountain is formed, and some of which crops out close at hand with highly inclined cleavage planes, so that probably large slabs could

be readily split off with wedges and then dragged or rolled to their present positions. No lintel, impost, or covering to the cist now remains, these having doubtless been long since removed for building and repairing fences. This removal and the fall of rubbish consequent thereon would in part account for so much broken pottery in the cists. Above the flooring of flat slabs and the buried urns, ashes and flints, the cist appears simply to have been filled in with loose stones and earth up to nearly the top of the side stones (see Fig. 1 on fig. 11). The burials were evidently all by cremation, 2 to 5 or more urns being deposited in each tangential cist or in the proximal end of the radials—we met with no such remains in the distal part of any radial cist.

Altogether we have been able to distinguish the remains of at least 26 distinct urns, all however in a fragmentary condition. With this pottery were some fragments of calcined bones, ashes and loose charcoal, also compacted lumps of bone, ash, and charcoal, with a certain amount of greasy black matter. A few flint instruments were met with, including three arrow heads (Fig. 2 on fig. 11), at least 5 knives, a scraper, and some broken pieces. In each cist also were found a number of rounded white quartz pebbles, from the beach, measuring 1 to 6 inches in diameter. These were found scattered through the grave without obvious arrangement, although they may originally have been carefully deposited on the floor around the urns or in some definite manner. In some other ancient burial places in the island similar white quartz pebbles, evidently brought from the sea-shore, have been used. Can this be the origin of the superstitious dislike the natives still have to the use of the "clagh-bane" or "white stone"? Fishermen, for instance, will refuse to go to sea in a boat which has a white stone in the ballast.



FLINTS AND POTTERY FROM CISTS.

FIG. 11.

In one cist—VI.A of our plan (fig. 10)—we found immediately beneath the pavement or floor a hole measuring 12 inches in diameter at the mouth and 12 inches in depth, filled with a fine dark soil like that *above* the floor of the cist, while with this exception all the floor stones rested on the undisturbed surface of the hard yellow mountain soil. This suggested that in this case an urn had been buried in the soil under the floor, and in fact nearly all the pieces of pottery and the flints were found beneath the floor stones. How far this position is due to the cists having been disturbed before, the contents turned over, and the urns broken it is impossible to say.

Now we shall note briefly any special characters of the tritaphs, commencing at the north-east corner (see fig. 10). We label the tritaphs I to VI, and the cists in each A, B, and C—B being in each case the radial one.

In I.A we found an old worn shell of *Littorina littorea*, also fragments of pottery which proved on examination to belong to at least 5 different vessels measuring from 9 to 12 inches in height and about the same in widest diameter. Other fragments, some evidently belonging to the same urns, lay in the central space between A and C.

In II.A in its north-west corner were loose pieces of charcoal and some burnt bone fragments, also traces of a black oily substance possibly the result of charred animal matter mixed with earth. We were told that 20 years ago a man named Fargher had dug a perfect urn out of cist C. No description or record of it was however kept, and the urn itself has disappeared. We think that it was in or beside this tritaph that in 1882 Mr. F. Swinnerton picked up a small beautifully finished flint arrow head.

In III.B a small flint scraper was met with, and in C some pieces of pottery belonging to 5 urns and 2 broken knives. The space between this and the next tritaph, an

interval of 16 feet, was tried in various places with spade and pick, but was found to be undisturbed mountain soil. It evidently formed the southern and main entrance to the circle (see fig. 12). A level track, like a road way, leads from here in a curve down the slope of the hill to the hut village (see figs. 9 and 10).

FIG. 12. View of stone circle from the south-east. The southern and northern gaps, and the groups of stones forming tritaphs, are easily seen.—From a photograph.

Tritaph IV., the first on the west side going from S. to N., had evidently been disturbed before, and some of the stones had been displaced and removed, but still on clearing them out the shapes and sizes of the cists were readily distinguishable. The next, V., was pretty perfect. In A some fragments of pottery belonging to 3 urns, calcined bones, 2 flint knives and 2 arrow heads were found, and in the central space between A and C some

pottery. In C were some fragments of pottery (at least 2 vessels) at the S.W. and N.E. corners, also a flint knife and another arrow head.

Tritaph VI. was also a perfect one, and cist A particularly so. In it some flints and pottery were met with in the N.W. corner, and in the centre was the hole excavated under the floor which had evidently once contained an urn and which is referred to above (fig. 11). In C some flints and fragments of pottery were found between the entrance pillars. This completes the circle. Between tritaphs VI. and I. is a space of 18 feet which we tried carefully with pick and spade and found nothing but soil and small stones. It had evidently been left intentionally as the northern opening of the circle, facing down the hill towards Port Erin Bay and Bradda Head.

With respect to the pottery, we found in all remains of at least 26 vessels the appearance of which showed that they had been used as cinerary urns, and along with them the remains of ashes, charcoal and calcined bones. With the exception of tritaph IV., which had been more disturbed before our examination than any of the others, and of II., from which, however, a perfect urn had been formerly taken, we found some pottery in every tritaph, but with two exceptions it was always in the tangential cists. The urns numbered from 2 to 5 in a cist, but there may have been more. From the fragmentary remains the vessels seem to have been all between 9 and 12 inches high and the outside diameter at the mouth varies from 8 to 11 inches. They show some diversity of shape, colour, lip, and surface (Figs. 3-5 on fig. 11). About seven vessels show traces of patterns. These are of the simplest kind, consisting of lines impressed diagonally or perpendicularly across the lips (Fig. 5 on fig. 11) and of lines diagonal, horizontal and perpendicular either drawn with a pointed

stick or formed by punctured holes on the walls. There is no colouring save that given by firing and stains. The paste appears in all to contain a mixture of the local slate and quartz, with a good deal of mica, probably from disintegrated granite which would be found in the boulder clay in the neighbourhood. With respect to shape the most notable thing about the vessels is that several of them appear to have had broad overlapping rims or lips (Fig. 4 on fig. 11), not a common type in the Isle of Man, and some also median bands and grooves. On the floor of one of the huts we found remains of a couple of small earthen vessels similar in colour, material and style to those met with in the cists.

It may be added, since the work in 1893, we have found further examples of flints and pottery in a couple of other huts excavated in 1896 with a view to the visit of the British Association that autumn. These pieces included some mediæval glazed pottery and fragments of a clay figure. including the greater part of a small mask of the human face. These were at a higher level than the ancient floor, and may be taken as an indication that some of the huts were occupied on into historic times.

The flints obtained have already been enumerated. The arrow heads were all of the same type, leaf shaped, showing secondary working and careful finish (Fig. 2 on fig. 11). Two are worked on both faces, the third, which has lost its point, is worked only on one face. The knives are all of the same type, the flat face left intact, the convex trimmed by secondary working on one edge only. The largest measures $2\frac{1}{16}$ long by $1\frac{1}{16}$ broad and $\frac{3}{8}$ thick.

The scrapers are small and rudely made. One of yellow flint measuring $1\frac{1}{8}$ inch by 1 inch and $\frac{5}{16}$ thick has the bulb of percussion at the broad end, the edges which are sharp and narrow are rounded to a point, and only

the edges show secondary working. A scraper of about the same size from one of the huts shows almost no trace of secondary working. An awl, or perhaps a knife, from the huts resembles one figured in Evans' "Ancient Stone Implements," figs. 235 and 239, but is smaller and broader in proportion. The point and the butt are rounded and both edges sharpened, but it shows very little trace of secondary working.

A much larger flint implement than any of those we found in the stone circle or the hut village, and which might be called an adze (fig. 13), was picked up a few years ago by Mr. Nixon on the Meayll Hill near Cregneash.

In conclusion, these remains seem to show that the people who inhabited the ancient villages on the Meayll and who erected and used the stone circle, were in the last days of the Neolithic or the beginning of the Bronze Age, living in small communities of 4 to 16 families, that they occupied the locality over a lengthened period, and were there when the later Celtic population settled in Man. They used pottery of a rude kind, made by hand, of materials obtained from the spot, for domestic purposes and as urns in which they deposited the ashes of their dead. The stone circle on the hill above the villages was used by them as a place of sepulture, and the only mode of burial there was by means of cremation. They hunted and fought with flint-tipped arrows, used flint scrapers to clean and prepare the skins of animals for their clothing, and the flint knives no doubt for various other purposes. In regard to the ceremonies of burning their dead and the burying of the ashes we can only conjecture, but the size and nature of the cists, the presence of the numerous quartz pebbles, the buried weapons and implements deposited with the ashes, all would seem to

indicate the funeral rites of a people imbued with some religious ideas however primitive.

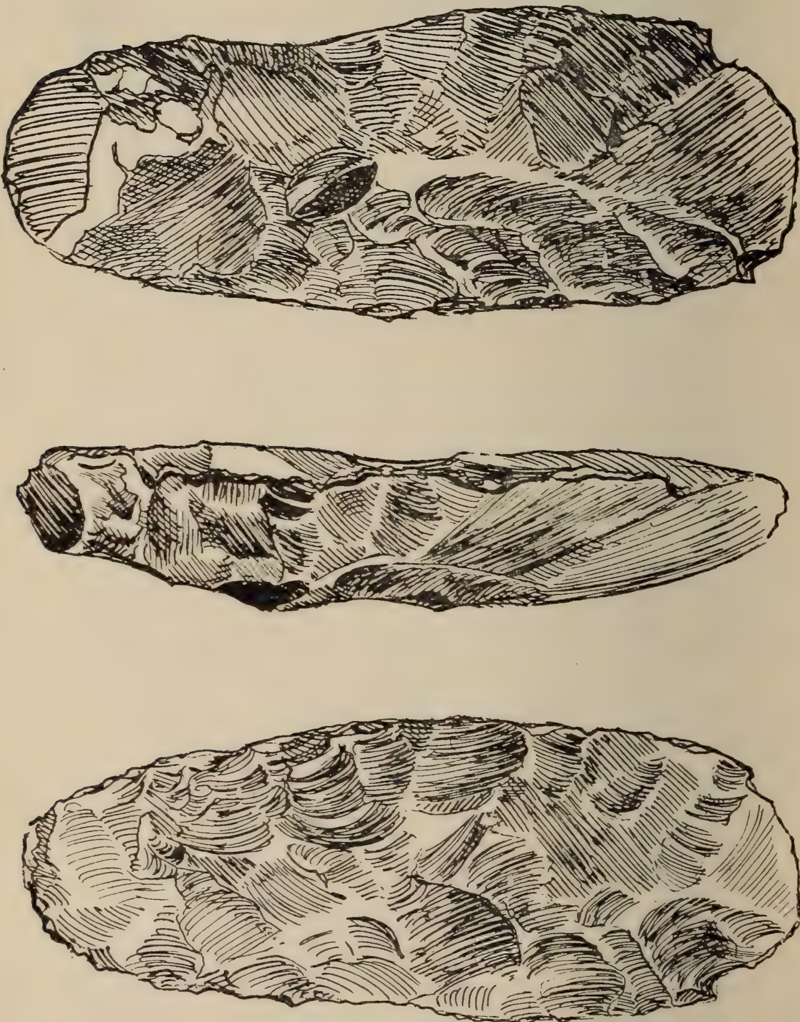


Fig. 13. Three views of adze, from the Meayll Hill.—From a sketch by B. S. Herdman.

We have done our best to make the examination of the huts and stone circle of the Meayll Hill as thorough as

possible, and what is perhaps of nearly equal importance we have lost no time in placing the results on record for future reference. We trust the proprietor may now be induced to make over the guardianship of this unique relic to the Trustees of the Manks Museum, in order that it may be thus preserved as a National Monument of interest not only to Manksmen but also to Archæologists in general. This was written in 1893, but no steps have yet been taken to protect the Meayll antiquities.

Returning now to other parts of the Island, we may mention here, as of still undetermined age: (1) A large circle of small and comparatively inconspicuous stones high up on the lonely shoulder of Bradda Mountain which overlooks Fleshwick, and (2) a very neat little circle, known as Cronk-Carran, formed of regular, for the most part, upright stones, and only a few yards in diameter, which is placed on a grassy patch part way down the cliff near the Chasms at Spanish Head. These have not been excavated, but will probably prove to be of late Neolithic or early Bronze Age.

The group of monuments commonly known as "King Orry's Grave" (fig. 14), in Laxey, appears to have consisted of a large cairn of stones, 30 feet in diameter, out of which arises a tall thin conical slab about 10 feet high (figs. 14 and 15); from this extends eastward a line of cists, formed of two rows of flat boulders, set edgeways, four feet apart. About 40 yards eastward across the high road are the remains of another large tumulus (fig. 16). Mr. Barnwell, Secretary to the Cambrian Archæological Association, which visited the Island in 1865, says human bones, the skeleton of a horse, an iron sword and horseshoe were found in opening this cairn, 30 years previously, but Dr. Oswald, a local antiquary who was in a position to know, mentions only a "tooth and remains of a horse."

FIG. 14. "King Orry's Grave." From a sketch by Sir Henry Dryden.

H

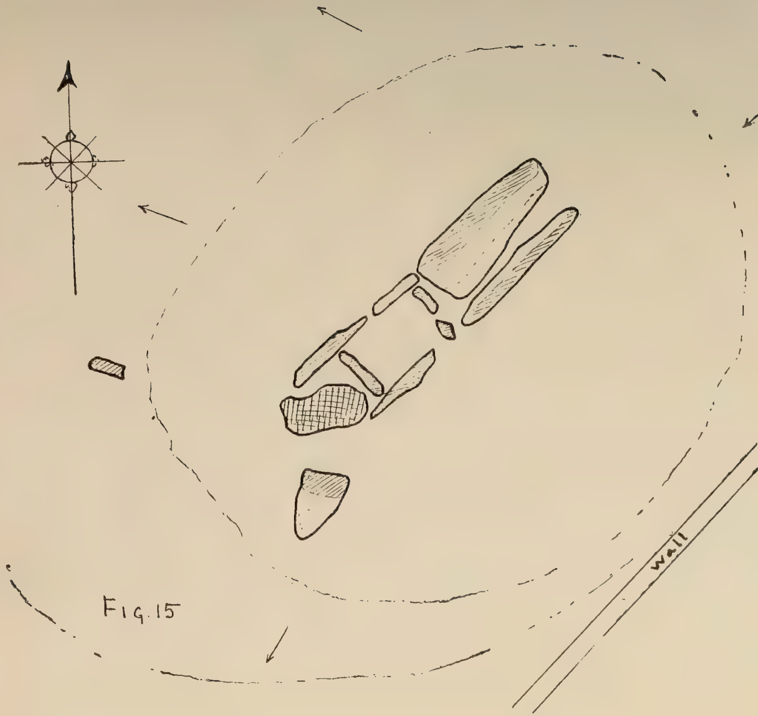


FIG. 15. "King Orry's Grave," plan of the western cist.

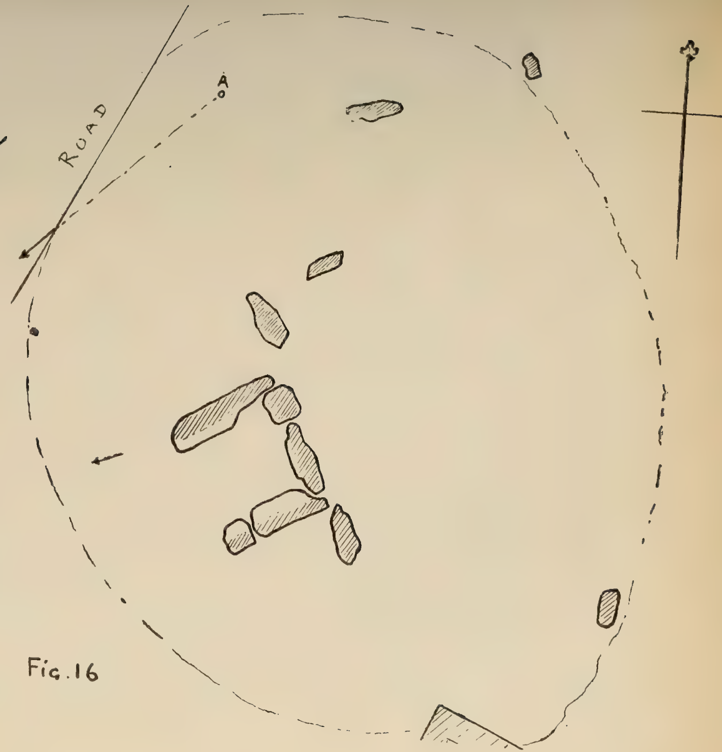


FIG. 16. "King Orry's Grave," plan of the eastern cist.

The Ballagorry Cairn (fig. 17), Maughold, consisted of a circle of massive stones, 10 yards in diameter, on the north-east side of which was an oblong platform about 4 feet high. On its south-east side was a line about 38 feet long of three or more cists, in which were found remains of a skull and other human bones, and a good deal of broken pottery; at either side was a line of larger stones set on end. The largest piece of pottery must have been part of an urn (food-vessel), about 7 inches diameter at the mouth. About 1825, when a sketch was taken by Dr. Oswald for the "Vestigia antiquiora" (Manks Soc., Vol. V., p. 66), the monument was surrounded by a rough walling of large stones. The covering consisted chiefly of quarried stones laid flat over each other, about 4 feet high, and an incomplete circle stood at the western end. The length from east to west of the remains is 105 feet, breadth at west end 50 feet, at east end 40 feet. The western part, including the circle, is 70 feet long, the east portion 35 feet, and lower than the other. There are also traces of a cross wall (a). The arc of the semi-circle is 70 feet, and the distance between the outer stones 32 feet. Oswald, 1860, had seen the platforms, the stones of which were used in building a new house. The circle remained untouched, its diameter being 10 yards—the circumference of the whole ruin is 90 yards. The largest stones are 10 feet high, and between the two central ones is an opening into the first cist 20 inches wide. In this cist, 10 feet long and 5ft. 6in. wide, with side stones leaning towards each other at the top, we found black carbonaceous and grey unctuous earth, with fragments of charcoal. Under the side stones were pieces of human bone—portions of a skull with the suture open, upper jaw bone, with teeth regular and sound, evidently of a young person, and other fragments; also pieces of at least two urns.

The eastern cist also contained bones and fragments of a smaller urn. The other chamber contained similar black carbonaceous and grey unctuous clay with charcoal and a few pieces of flint.* In form this remarkable monument shows some resemblance to the Neolithic long Barrows found elsewhere in the British Islands.

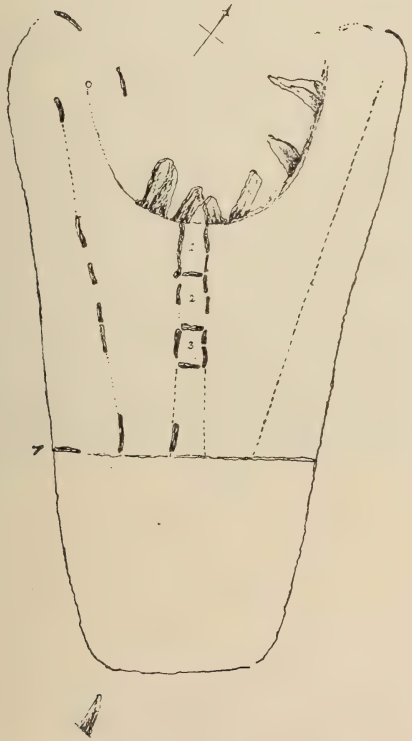


FIG. 17. Ballagorry Cairn, Maughold. Sketch by Rev. S. N. Harrison.

The remains marked on the Ordnance maps at Kew, German, consist of an avenue of upright stones leading to a tumulus which has not been opened.

* Reliquary, Vol. XXV., Pl. XIX., 1884. Trans. Soc. Antiq., Scot., Vol. II., Part 2.

The monument on the Braid, Marown,* is a large circular mound of earth and rubble about 3 feet high, with slabs on end set around (fig. 18). The diameter, inside, is about 12 yards. An entrance on the south is distinguished by two upright stones facing each other, about a yard apart. Alongside on the N.E., and apparently associated with it, is a remarkable avenue about 36 yards long by 10 yards wide, formed by two substantial

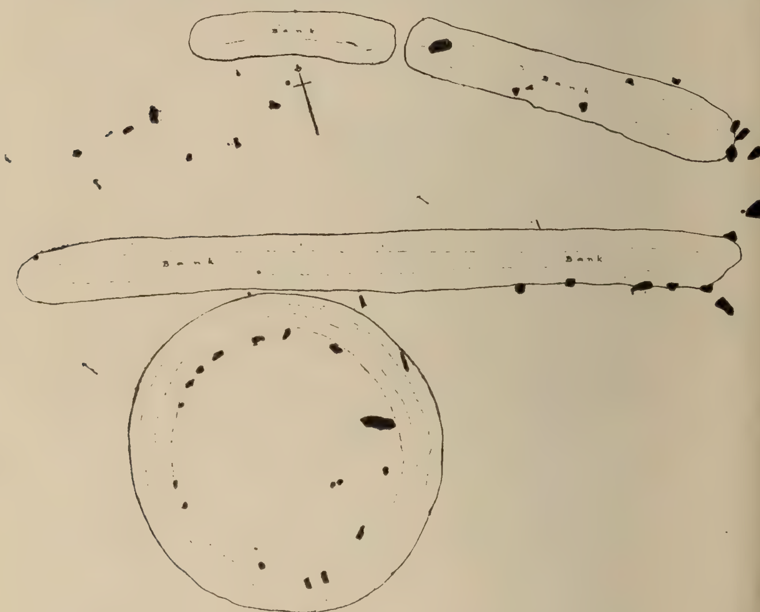


FIG. 18. "Mount Murray" Circle: Plan of the remains on the Braid, Marown, after Sir H. Dryden.

embankments of earth and large stones. Between this and the circle are two rings of stones on end, evidently remains of a tumulus from which the soil has been removed.

The remains of a circle which may have been of

* Sometimes called Mount Murray Circle.

similar character are to be seen at Glen Aldyn, Lezayre, near Ramsey. There is a ring tumulus consisting of a circle of white quartz boulders about 40 feet in diameter. On the south a portion of the rubble mound remains, exposing a cist (see fig. 19) 3ft. by 1ft. 6in., and 2ft. high (inside

FIG. 19. Stone Cist at Glen Aldyn. (Photograph by M. McWhannell.)

measurements). There were other similar cists, containing urns and ashes, which were exposed when the greater part of the surrounding circular mound was removed in making the mountain road about 300 yards above. It is probable that the circular mound on the Braid, if excavated, would show similar chambers.

The Bronze period in the Isle of Man was not merely a stage in civilisation. There is no reason to doubt that the Neolithic people here were the same Iberian, pre-Aryan folk who occupied the rest of the British Islands for a lengthy period previous to the arrival of the Celts. Similarly we may quote Professor Boyd Dawkins' words

in regard to the coming of the Bronze Age people as applying to the Isle of Man:—

"The tall, round or broad-headed Celts . . . composing the van of the great Aryan army, ultimately destined to rule the West, brought with them the knowledge of bronze into Britain, and are proved to have conquered nearly every part of the British Isles, by their tombs scattered over the face of the country, alike in England, Scotland, Wales and Ireland. The conquered peoples survived probably in a state of slavery, and were only preserved from absorption in the West, where further retreat was forbidden by the waters of the ocean."*

It is natural to suppose that these invaders on first establishing themselves spread over England and some parts of Wales and Scotland before they came to the Isle of Man, and, when they did arrive in the island, they were probably in the later division of the Bronze Age, that period of which bronze swords, palstaves, and socketed celts such as have been met with here are characteristic implements.

The dwellings appear to have been similar to those of the Neolithic folk—possibly larger and better built. It may well be therefore that some of the groups of huts to which we have referred as originating in Neolithic, continued in use in Bronze times. As we have stated there is some evidence that those on the Meayll Hill were occupied even far later.

We have records also of crannoges, or pile-dwellings, artificial islands formed of stones, tree-trunks, and smaller stuff piled up, in a lake or morass, and kept in position by stakes so as to make a platform upon which huts could be built in a secure position, surrounded by water. Elsewhere these lake-dwellings are mostly of Neolithic or Bronze

* Early Man in Britain, p. 343.

Age, though some have remained in use into historic times. Until the Manks examples have been more carefully examined it is impossible to say to which precise period they belong.

Comparatively few loose articles of bronze have been recorded, and of these most have been lost. So far as is known, those found consist of celts plain and socketed, palstaves, swords, dagger and spear heads, and sickles (see fig. 20, showing a group of characteristic forms).

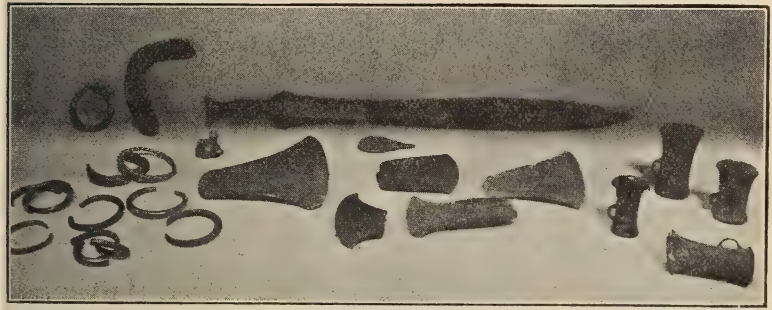


Fig. 20. Bronze weapons from the Isle of Man.

Many of the polished stone implements, all of which appear to be of foreign material, must have been introduced during this period (see fig. 21, which shows some of those now collected at Castle Rushen).

Fig. 21. Manks polished stone implements of Bronze Age.

Though but few bronze articles have been met with, a considerable amount of pottery belonging to this period has come to light, generally, however, in fragmentary condition. This consists of cinerary urns and food vessels, turned on a wheel, frequently ornamented and generally of superior manufacture to that of Neolithic times. Types of the various patterns found are shown in fig. 22.

FIG. 22. Bronze Age pottery, from the Isle of Man. Reduced from sketches by P.M.C.K.

Several smaller urns, much more highly decorated, have been found and probably belong to this time. The one shown in fig. 23 with a five-angled star inscribed on the base was found at Cronk Aust, near Ramsey, and contained burnt bones and earth. Another somewhat similar in type was found, empty, in a stone cist near Laxey.

With the Bronze civilisation, the practice of inhumation in cists formed of heavy slabs of stone gave way to that of cremation, although both were for some time carried on simultaneously. Our few implements have

been generally found scattered on or near the surface, seldom in association with other remains, but our knowledge of the pottery is derived solely from the burial

FIG. 23. Two views of a small urn, from Cronk Aust.

mounds of this period, such as those above referred to, which appear to have continued in use for a long time, as well as others of later date. The small round tumuli or cronks, still so numerous, for the most part appear from their contents to belong to this age.

We shall now describe one or two typical examples of these. A mound at Ballaseyr, Andreas, examined about 25 years ago, when it was being cut through in order to form a new fence, was found to measure 4 to 5 feet high by about 24 feet diameter at the base; it was composed entirely of heavy red sand. Near the centre, placed mouth downwards on the original surface, was an urn (one of those shown on fig. 22) half full of calcined bones, measuring $16\frac{1}{2}$ inches high by $15\frac{1}{2}$ inches in diameter across the mouth. The material is a stiff clay with the usual mixture of crushed stones, in this case slate, quartz, granite and trap, from the size of a mustard seed to that of a French bean. The surface is smooth, the colour reddish brown. A border pattern 4 inches deep consists of two lines round the urn, between which four rows of diagonal lines form a sort of herring-bone pattern. Within the bevelled lip is ornamented by two lines, between which are short diagonal strokes. All the lines are formed as if by a bluntly-pointed stick, or possibly by pressing a twisted cord on the plastic clay (see fig. 22).

Another mound at the White House, Michael, examined in 1888, when it was removed for building purposes, stood about 7 feet high, and when perfect the diameter was about 40 feet. It consisted of a bed of red sand, $2\frac{1}{2}$ feet at its greatest thickness, upon which was heaped a cairn of broken quartz, $2\frac{1}{2}$ feet deep at the centre. Above was another 12 inches of red sand, and some 6 inches of surface soil. It was in this sand, resting directly on the quartz, that the urns were met with,

together with some charcoal and flint flakes. Six urns, all broken by down-growing roots of gorse, bramble, and grass, measuring from 8 to 12 inches high, were found, one of which was ornamented by lines of short strokes without definite design; one also had a sort of chevron pattern inside the lip. These contained incinerated bones and earth. The largest was 28 inches in diameter. Another, $9\frac{1}{2}$ inches high, was 9 inches in diameter. When subsequently the rest of the mound was removed, no more pottery was met with, nor was there any trace of a cist.

Another mound at Cronk Aust, Lezayre, now levelled,* measured 30 feet diameter and 6 feet high, and was composed of soft red sand and gravel. Near the centre was a small urn (fig. 23), filled with calcined bones, and placed mouth *upwards*, just above the original level of the soil, upon a thin band of dark burnt earth and charcoal. It measured $4\frac{1}{2}$in. high by $6\frac{1}{2}$in. greatest diameter, and was of unusual shape, decorated with simple but effective design.

In this mound, about six feet from the last urn, was a larger one, 12in. high, with diameter across the mouth $9\frac{1}{2}$in., and across the bottom $3\frac{1}{4}$in. This also was filled with calcined bones, and set, mouth downwards, about 4 feet below the surface of the mound. A flint, possibly a rude arrow-head, $1\frac{1}{4}$in. by $\frac{3}{4}$in. was found with some ashes about eight yards away, and about 6 feet below what appeared to have been the original surface.

Many of the mounds in the North and West of the Island have been found to contain from one to twelve, and even fourteen urns, measuring from 12 to 14 inches high (some were much larger), and sometimes highly ornamented. They are generally placed mouth downwards, sometimes on a flat stone, and are filled with burnt bones.

* Yn Lioar Manninagh, Vol. I., p. 89. Manx Book, Vol. III., p. 91.

Unfortunately, only a few broken fragments have in most cases been preserved (fig. 22).

Very rarely have bronze articles been met with in these burial mounds. Only two instances of bone implements are recorded. Of the very few silver ornaments found in the Island some may possibly belong to this period, but in the absence of any direct evidence it would not be safe to speak with certainty.

It is, in the present stage of our knowledge, difficult to say whether there was a distinct Age of Iron in the Isle of Man, and, if there were, when it merged into the Historic Period. A few of the pre-Christian burials, however, would seem to belong to this division, of which they constitute the most satisfactory evidence. Although cremation was still carried on in the Iron Age in Britain, a change began in the burials, and the dead were frequently interred laid at full length in a stone chamber, or shallow pit, along with articles used in the daily life.

A tumulus at Lhergy-rhenny, on the S.W. shoulder of Snaefell, levelled in order to obtain material for fencing in 1883, may have belonged to this period. The mound was between four and five feet high, and over 16ft. diameter. On its N.W. side was a small cist of flat stones set on edge, with some minute fragments of pottery on a layer of ashes. Near the centre was a chamber built of stones carefully laid flat, with sods between them, covered by a capstone a few inches below the top of the mound. The chamber measured 5 feet long by 2½ feet wide, and 2½ feet deep, but nothing was found in it. Just below, and at a different angle, was a similar wall of another chamber on a layer of wood ashes, resting on flat stones, which appeared to have been laid on the original surface. Here and there in the mound were pockets of broken red quartz and small fragments of baked pottery.

The Rev. S. N. Harrison, in 1884, opened a mound on the Barony, Maughold, in the centre of which was a long grave, E. and W., lined on the sides with flags, and having a flag-stone at the W. end, but the E. built up. To the north was a second stone-lined grave; above were traces of ashes.

In a field at Bishopscourt a mound previously reduced almost to the level of the field was examined in 1888 and found to contain a cist about 5 feet long, formed by two side-stones set on edge; in it were remains of burial by inhumation, the body having been laid on its side, head northwards, the knees apparently doubled up. A large slab, 8ft. 6in. long by 16in. wide, might originally have been set upright at the head of the grave. Some charcoal was met with outside the S.E. corner of the cist. Another close by had a capstone 3ft. 8in. long by 2ft. 8in. It was filled with loose sand, but fragments of a skull were met with; also a small urn (full of sand) the shape of a flower-pot, $3\frac{3}{4}$in. high by $4\frac{1}{2}$in. diameter at the mouth, and $1\frac{7}{8}$in. at the bottom. Both cists contained broken red quartz, and rounded white pebbles.

Some of the mounds still existing may belong to a much later date, that, namely, of the Scandinavian settlers, who arrived as pagans about the end of the 9th century, and became Christian in the 11th. Though this Scandinavian nature of some of the burial mounds is certainly likely, we are not aware of any evidence as yet recorded on which to determine the question.

Tynwald Hill itself may possibly have been in its origin a burial mound of peculiar sanctity, afterwards converted into a place of assembly. Whether this was so before the Scandinavian occupation there is no evidence to show, but the name at all events dates from that period. It resembles the "Moot-places," of which remains are still

found in Iceland and Norway, and a few in England and Scotland. In these there was always a plain (*voll*); a hillock or mound; a court due east of the hill, and a temple. Tynwald Hill in its present form is an artificial mound, consisting of four circular platforms, the first having a circumference at the bottom of 256 feet, and at the top of 240 feet; the second platform has a circumference at the bottom of 162 feet; the third of 102 feet, and the fourth of 60 feet. It is situated at St. John's, 2½ miles from Peel, and is the scene of the formal assemblies held at least once a year on July 5th (Midsummer Day, old style), when the new laws are read to the people in the open air.

Cronk-Howe-Mooar, "the Fairy Hill," is a very striking, regularly shaped mound, lying on the low ground behind Port Erin, and between Port St. Mary and Fleshwick. If wholly artificial, it is one of the largest and most remarkable works of prehistoric date in the Island, and forms a truly magnificent tumulus. It is probably, however, in great part a mass of gravel and sand, left by floods after the recession of the ice-sheet of the glacial period, and very likely artificially shaped, and possibly fortified at the top in prehistoric times.

The name of this mound is an example of the pleonastic or needless repetition of the same term in the successive languages used in a district by the invaders, each ignorant of the meanings of names they found—Cronk-Howe-Mooar-Hill signifying simply the great Hill-Hill-Hill in the three languages, Gaelic, Scandinavian, and English. And probably each successive race has associated the mound—as it, like many Neolithic structures, is still associated—with the supernatural, or, at least, with fairy lore. Such veneration and superstition lingers on to our own day, for we are told that in 1859 "a farmer in the Isle of Man offered a heifer up as a propitiatory sacrifice, so

that no harm might befall him from the opening of a tumulus upon his land."

The Historic Period is represented by structural and monumental remains, dating from the introduction of Christianity to the earlier Celtic inhabitants in the sixth or end of the fifth century. Among these remains are a number of inscribed stones and incised and carved Cross-slabs (see figs. 24 to 42); and the ruins and foundations of early Keeils, Cells, or Churches.

Dr. Oliver, in the Manks Society, Vol. XV. (1868), describing the ancient churches in Man, states that "In their materials and construction they correspond with the account given in the *Book of Armagh* of similar places of worship in Ireland of the age of St. Patrick. When the Apostle visited Tirawley (he quotes) he built there a quadrangular Church of moist earth, because there was no wood near." Here, he adds, "we have an exact description of the Manx cabbal. . . . The cabbal and keeil are invariably quadrangular, the lights oblong or quadrilateral openings, splaying inwards, and the stonework of the doors and windows unchiselled." Since his time many buildings and ruins have been utterly demolished, and we are unaware of any instance answering to his description of "the Cabbal of the Fifth Century," of which he gives a figure, but does not say what it is taken from. He then goes on to describe the keeils, which he supposes to have been "introduced about the middle of the sixth," of which he gives St. Lingan's, Marown, as an instance; the "Treen" Churches, "introduced towards the close of the eighth," instancing Ballakilley, Malew; and "Mortuary Chapels," such as St. Luke's, on the western slope of Cronk-ny-Irree-Laa, Rushen. We are unable to follow his classification, or to agree (from what little can

be learned from still existing remains) with his descriptions in every particular.

The following are the most interesting of which traces still remain:—

Keeil Woirrey, in Corna Valley, Maughold, measures (inside) 12 feet by 9 feet, the walls over 3 feet thick and 4 feet high, but 2 feet high outside. The floor shows signs of pavement. The doorway is at the S.W. corner. The surrounding burial ground measures about 93 feet by

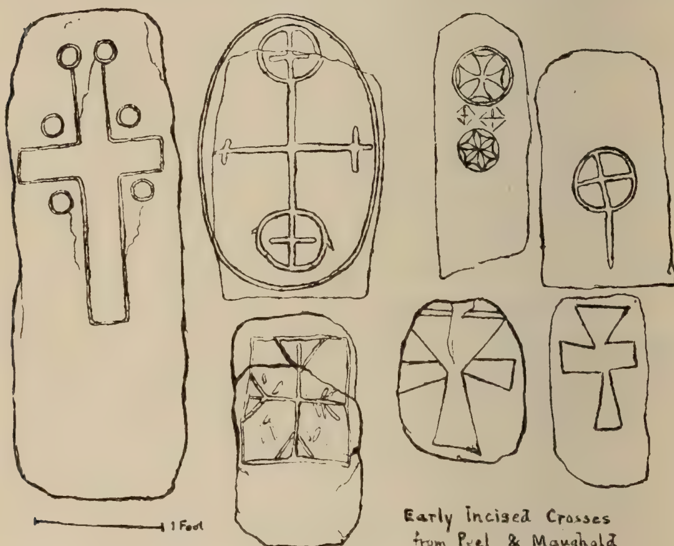


FIG. 24.

60 feet. Among the stones of the ruined wall was one bearing a very simple form of cross, which judging from its appearance may be earlier than the seventh century (see fig. 24, left side). Near this keeil, an interesting discovery was made some years ago by the Rev. S. N. Harrison, who came across a rough unhewn slate slab, used at a well beside the little stream below, which bears an inscription (see fig. 41) in the ordinary Manks runes—

with a formula differing from any previously met with, namely—

Krist, Malaki, and Patrick (and) *Adamnan. Unal* (O'Neal's) *shepherd Juan carved this in Kurna dale.*

Probably it was cut in the 13th century by Juan of the sheep, while watching his master's flock in the valley, and he was thus distinguished from another, namely, "Juan the Priest," who about the same time carved runes on a somewhat similar rough slab at the parish church.

On Ballafayle, in the same parish, overlooking the sea at the south end of Port Mooar, are the remains of Keeil Casherick, or Keeil Chiggyrt, as it is also called. In the surrounding burial ground was found a wheel-headed cross-slab, now to be seen at the parish church. Sculptured on one face is an equal-limbed cross with knot-work decoration, below which is a human figure probably intended for Christ.

On Ballingan, Marown, are the ruins of a keeil and burial ground. The enclosure is 108 feet long by 63 feet broad. In the south-east part lies the keeil, its walls about four feet high by three thick. In the west end has been a window; the doorway is in the south-east angle, built of rubble stone work with two monolithic jambs inclining. The font measures 1 foot 11 inches long by 10½ inches broad.

Sir Henry Dryden has left (1873) an unpublished plan of another keeil on the adjoining estate of Ballaquinney in the same parish, which we reproduce as a typical instance (fig. 25). It measured 15 feet 4 inches by 10 feet inside. The door is in the west wall, 1 foot 9 inches wide, and the walls are about 5 feet thick.

Dr. Oliver gives an account* (1868) of a Treen Church

* Manks Society, Vol. XV., p. 88.

at Ballakilley, Malew, with a gable which we here reproduce (fig. 26). It is about 50 yards from the farmhouse, and measures 21 feet by 9 feet. "The western gable crowned with ivy is still standing, but the east end is in ruins.' It is built of rounded boulders of granite and quartz, giving it a very peculiar appearance. The walls are "6 feet 3 inches from the ground to the spring of the roof; and the western gable 16 feet 9 inches to the peak. In the south wall near the eastern angle is the door of entrance, 5 feet 2 inches in height, by 2 feet 6 inches at base, diminishing upwards to 2 feet. Opposite, in the north side, is a square-headed window, and another in the south wall near the west end. This window externally is 2 feet 6 inches high by 1 foot 6 inches broad, splaying inwards; internally 2 feet 6 inches by 3 feet. In the north-west angle of the gable is a similar window, 1 foot 5 inches by 9 inches, splaying internally to 20 inches in breadth and 17 inches in length (see fig. 26).

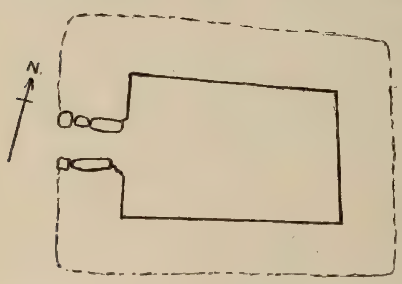


Fig. 25. Plan of keeil at Ballaquinney, in Marown, after Sir H. Dryden.

One of the most interesting of these early keeils is that known as St. Luke's (St. Luac), on the lonely shore at the western foot of Cronk-ny-Irree-Laa. Oliver (*Id.* p. 89), upon what authority we do not know, says "It is traditionally known as the Church and Cemetery of the Danish Kings." It is a stone erection, built without cement, "but the masonry is more regular and much better constructed" than in the case of these other keeils. The floor was paved with pebbly stones. It measures, outside, about

18ft. by 15ft., the walls being about 2ft. 6in. thick, their inside height 4ft. from the floor, outside 3ft.

Burial, in the ancient cemeteries round these keeils, was in "lintel-graves," about 3ft. deep and 2ft. wide, dug east and west, and lined with small flagstones to the height of 15 inches. The corpse was wrapt in a mort-cloth, and the top closed in by similar, sometimes rather larger flags. No implements or relics have been found in any of these graves. Sometimes, says Oliver, two and even three bodies rest in the same grave. "When this is the case they will be found to lie on their sides, with the lower extremities semi-flexed. In consequence of this the grave is smaller,

FIG. 26. Treen at Ballakilley.

having the appearance of a child's burial. Three or four such graves may be seen in section at Kilkellane, Lonan, where the electric tram road has cut through a burial ground. Sometimes such early cemeteries are found where now there is no trace or tradition remaining of the keeil which must once have stood there, as at the Flagstaff above Glen Wyllin, Michael, and by the old Castletown road from Foxdale, on Barrule Farm. Occasionally these lintel-graves are met with even in the Parish Churchyards, having continued in use until the commencement of the seventeenth century.

It is in connection with these old keeils and the later Parish Churches, some of which are on the ancient sites, that those carved stone monuments have been found in which the Isle of Man is so peculiarly rich. With but few exceptions these are sepulchral, and take the form of upright slabs of local stone, ranging from about 2ft. 6in. to six and, in a few cases, seven or eight feet high, by about 15in. to 24in. wide, and from two to four inches

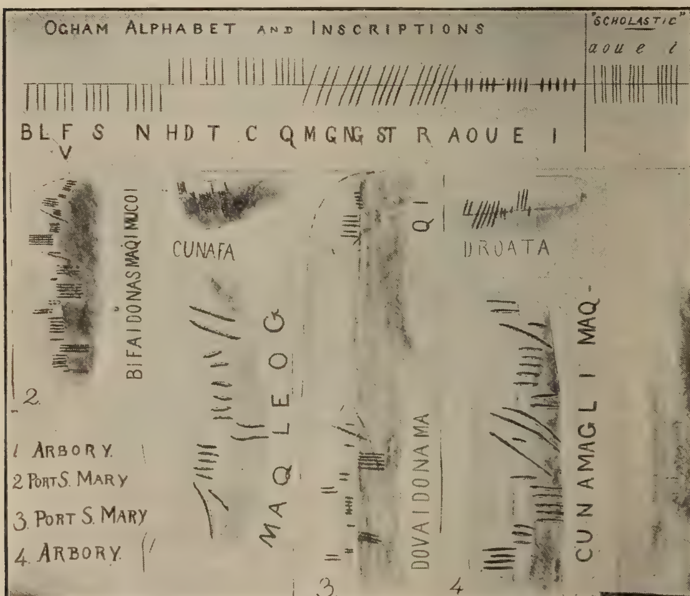


FIG. 27. Ogam inscriptions. Diagram by P. M. C. K. Scale $\frac{1}{15}$th.

thick. They are generally "rectangular, sometimes having the upper corners rounded off, and sometimes the whole head in what has been called a wheel-cross. Occasionally the spaces between the limbs and the surrounding circle are pierced, and, in a very few instances, the slab is itself cruciform."*

* Catalogue of Manks Crosses, P. M. C. Kermode, 2nd Ed., p. 4.

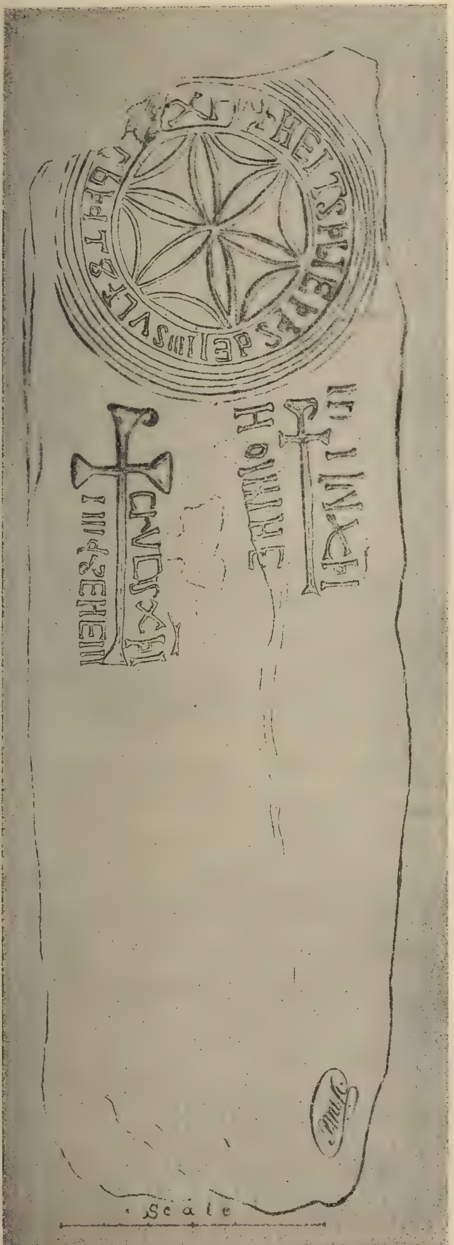


Fig. 28. Inscribed stone from Maughold.

Of the inscriptions, a few are in "Ogams"—characters forming an artificial alphabet, invented possibly by Irish scholars, who had become acquainted with the Roman inscriptions in Wales. Two of these have been found at Bemaken Friary, Arbory, and two in the burial ground of an early keeil at Ballaqueeney, Rushen. In language and character they exactly resemble Irish inscriptions of about the fifth century (see fig. 27).

One or two are in debased Roman, or Early British characters and Latin language of the sixth, seventh, or eighth centuries. The most interesting of these is a small slab found at

Maughold, by Mr. P. M. C. Kermode, in 1901, and figured and described in "The Reliquary and Illustrated Archæologist,"* July, 1902. Around a circle enclosing a Hexafoil design is the following inscription, of which, unfortunately, the beginning is broken off:—NEITSPLI EPPS DE INSVL. It is here met by some characters running in the opposite direction, of which one can make out the letters—BPAT. Below the circle are two small crosses (of the very rare form met with at Kirk Madrine, Wigtown) down by the sides of which runs the following unique formula:—

[FECI] IN XR̄I HOMIHE
CRVCIS XR̄I IMAGEHEM.

With two exceptions the H form stands for N (fig. 28).

This is probably earlier than the 8th century. Another cross, formerly on a hedge at Port-y-Vullen, Maughold, but now in the churchyard, bears across the edge the simple inscription, *Crux Guriat,* a name met with in North Wales in the 9th century. The upper part of our figure 29 shows the inscription from a rubbing, one-fourth actual size.

The greater number of these inscriptions are, however, in "Runes," the peculiar characters developed three or four centuries before the Christian era by the Goths, who came in contact with the Greek colonists from the Black Sea trading for amber. These characters underwent great changes in the course of centuries, and are classed according to their period as Gothic, Anglian, and Scandinavian. A solitary example of the Anglian runes of about the eighth century has recently been found at Maughold. Only eight characters now remain, a twelfth part of the

* We are much indebted to the courtesy of the publishers of that periodical for the kind loan of some of the blocks which illustrated Mr. Kermode's paper.

Fig. 29. Inscribed Cross from Kirk Maughold. *Crux Guriat.*

Fig. 30. Crosses at Conchan, restored. Typical examples of Celtic decorative art.

inscription, if, as seems likely, it was continued round the circle. They are perfectly legible, reading—BLAGC-MAN. The stroke between the C and M may be accidental, or it may be a punctuation sign. If forming one word, this would make a known Anglo-Saxon name. The rest of the Manks inscriptions are in the later Scandinavian runes of the tenth to the thirteenth century.

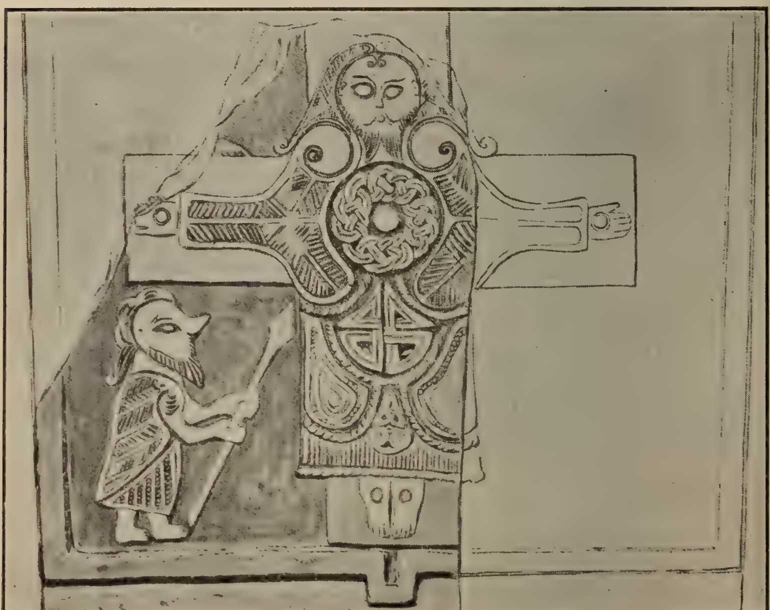


FIG. 31. Cross from Calf of Man.

The earlier pieces are of unhewn stone, and bear on one or both faces incised crosses of different forms (fig. 24). Later, we find the crosses sculptured in relief, and the stones more or less elaborately decorated, "a regular development may be observed from the most simple plait and twist to the most complex and beautiful geometric designs, and then from the geometric to the zoomorphic

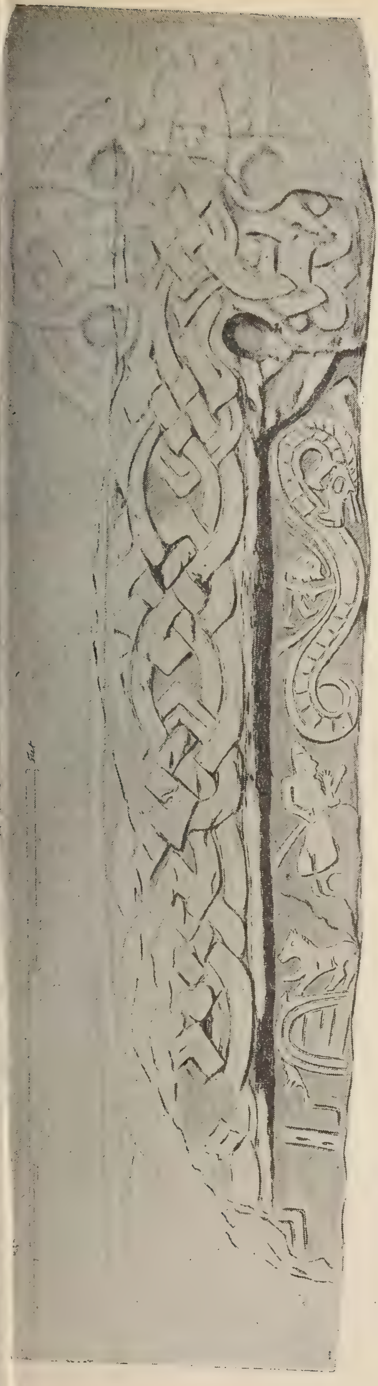


FIG. 32. Sigurd. Jurby.

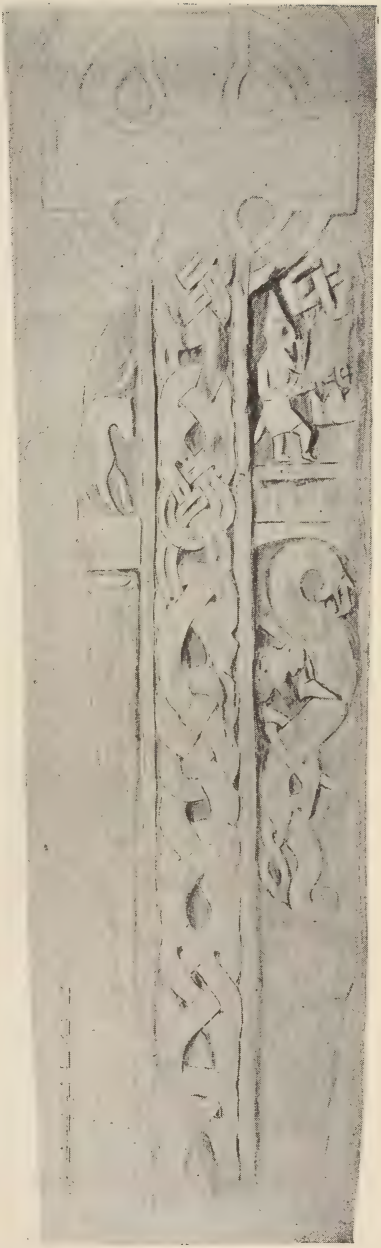


FIG. 33. Sigurd. Malew.

FIG. 34. Odin. Jurby.

FIG. 35. Hrae-svelgr (Grim's Cross). Michael.

Fig. 36. Heimdall. Jurby.

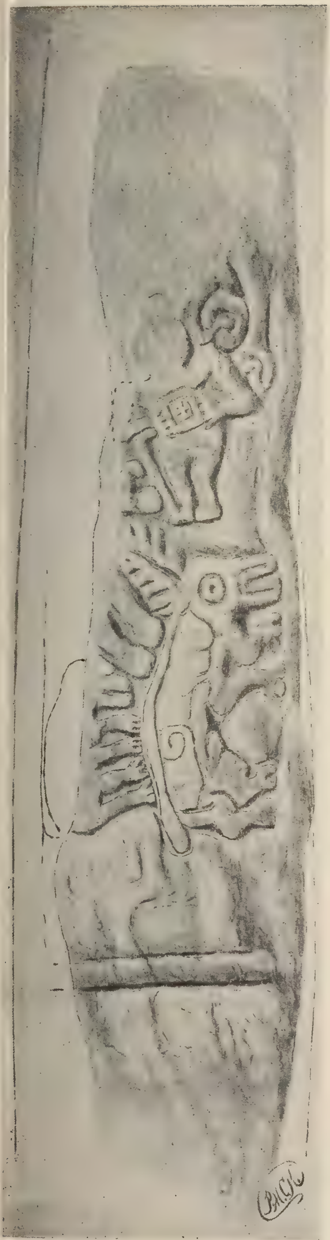


FIG. 37. Bishop's Monument (?)
Kirk Maughold.

FIG. 38. Celtic Cross.
Kirk Maughold.

FIG. 39. Roolwer Cross, front and edge.

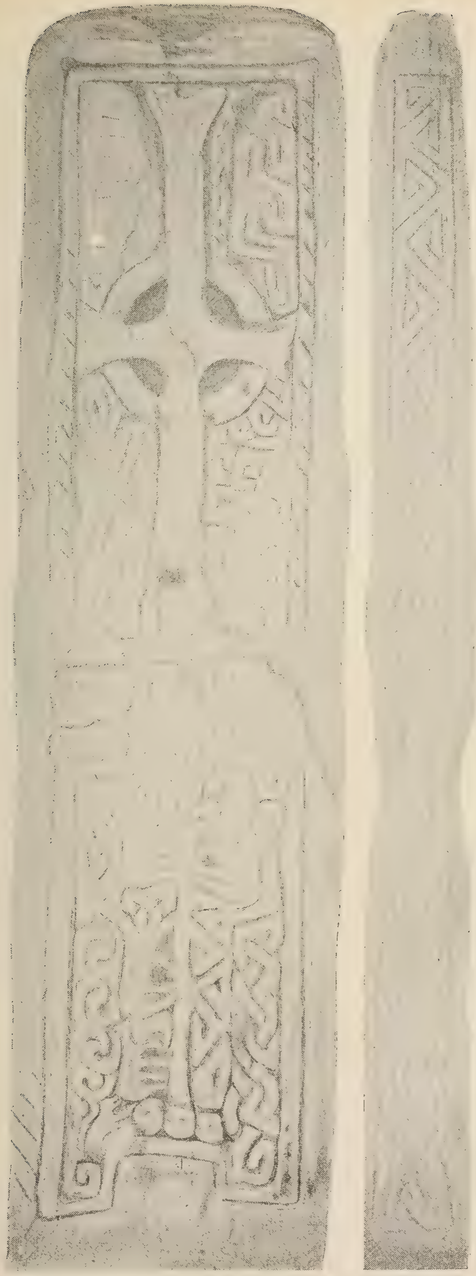


FIG. 40. Roolwer Cross, back and edge.

Fig. 41. Runic Inscription from Corna in Maughold.

(figs. 29 and 30). A striking feature is the realistic and admirably drawn forms of birds and beasts of the chase and of men, though the latter are not generally a success, and occasionally of the human form with heads of birds or with wings."* Some of the designs, as well as the general decorative treatment, are peculiar to the Isle of Man, and all exhibit true artistic feeling, and most of them skill in execution. A few of the older Celtic pieces exhibit Scripture scenes:—The Temptation of Adam and Eve (Bride), Daniel in the Lions' Den (Braddan), The Virgin and Child (Maughold), and the unique Crucifixion from the Calf of Man, an example of pure Byzantine art (fig. 31). It is also of peculiar interest to note the work of the first Scandinavian Christian sculptors, following the earlier Celtic models with great freedom and evolving effective designs from the most simple motives. Finally, we find on later pieces illustrations from the old Norse Myths (figs. 32 to 36)—a series illustrating the story of Sigurd Fafni's-Bane, and figures of the gods Odin, Thor, and Heimdall, and of giants, dwarfs, and monsters. A complete collection of casts of over 100 crosses taken by Mr. T. H. Royston, of Douglas, finds a temporary location in the Masonic Rooms, Ramsey, and nearly all have now been figured for Mr. Kermode's book on the subject. We reproduce in the preceding eight pages, a series of ten typical examples, as follows:—

Fig. 32 shows a slab 7 feet long which was found as gate-post of a field at Jurby. Alongside the shaft of the cross we see, above, Sigurd in his pit—here ingeniously represented as a hollow mound— in the act of slaying the Dragon; below, he is shown sucking the thumb he had burnt in roasting the dragon's heart. One of the talking birds and Sigurd's steed Grani are also shown.

* Catalogue of Manks Crosses, 2nd Ed.

Fig. 33 is a slab 5 feet long, from Malew, showing on the right, below, Sigurd from his pit piercing the Dragon. Above, Sigurd is shown holding the wand upon which the dragon's heart is roasting over a fire represented by three triangular flames, and sucking his burnt thumb which reveals to him the knowledge of what the birds around are saying. On the other side the steed Grani is shown, above, and below the panel is broken. The three Sigurd pieces known from the Island are claimed to have been carved by the famous Gaut Bjornsen, of Cooly.

Fig. 34 is a fragment from Jurby, showing a stag and a boar to the right, and on the left a scene which is probably eagle-headed Odin taking a hero to Valhalla.

Fig. 35 shows what is known, from the inscription on it, as "Grim's Cross," from Michael. On the right at top is the wind-giant, Hræ-svelgr, corpse-devourer, in the form of a war-eagle or vulture tearing the body of some hero unknown.

Fig. 36.—The head of the inscribed cross from Jurby shows Heimdall, the warder of the gods, standing at the foot of the rainbow bridge (Bifröst) blowing a blast on his horn (Gialla) to summon the gods to their last great battle at Ragnarök, where they have to encounter the giants, demons and powers of evil.

Fig. 37 represents a sculptured slab from Kirk Maughold which, from the figure with book and pastoral staff, is possibly the monument of a bishop. The rest of the carving shows scenes of the chase—a stag and one or more hounds.

Fig. 38 is a very beautiful example of pure Celtic design and workmanship. It served for many years as lintel to the west door of Kirk Maughold. Here again a figure of a priest is shown, with stags and hounds below.

Figs. 39 and 40 show the two sides of Roolwer's Cross, Maughold, which Mr. Kermode believes was set up to the memory of Hrolfr, a Scandinavian who, as "Roolwer," is recorded in Chronicon Manniæ as being Bishop in Man about 1050.

Fig. 41 is the slab from Corna with the runic inscription carved by John-o'-the-sheep referred to above. The similar example of runes "writ by John the Priest" is unfortunately too large to be reproduced on our page. A figure of it will be found in Mr. Kermode's paper in "The Reliquary" for July, 1902.

The most notable ancient structures of the Historic Period are the Castles of Peel and Rushen. With respect to the former, which stands on St. Patrick's Isle, about $7\frac{1}{2}$ acres in extent, we have already referred to the mound near the centre of the islet as having possibly been a stronghold since neolithic times. The first buildings of stone would probably be the originals of the Chapels of St. Patrick and St. German, and, next to these, perhaps, the Round Tower on the highest part of the Island. The upper part of the latter has apparently been rebuilt in mediæval days, but it is likely that it was never much higher than now, resembling in this respect the Towers at Turlough and Dromiskin, in Louth. It is 50 feet high, the circumference at base is 45 feet. About 7 feet above the ground is a doorway looking eastwards (facing the entrance to St. Patrick's). The tower is built of sandstone regularly laid in courses, the wide jointings filled in with extremely hard shell mortar. Near the top are four square-headed apertures facing the cardinal points, and one other lower down on the N.W. or seaward side. It is, as now seen, more cylindrical than the Irish towers, but its design and use as belfry, and as keep in which relics and valuables were deposited, and into which

the ecclesiastics could retire for security, were no doubt suggested by these.

The Cathedral is cruciform, having a central tower, but without aisles or porches. Its internal length is 114ft. 6in., the width at the intersection of the transepts is 68ft. 3in. The height of the tower, including the square belfry turret, is 83ft., and of the choir wall 18ft.; the thickness of the wall 3ft. The Rev. J. Quine thinks the Early English, Decorated, and Norman chancel was built during the Episcopate of Michael, about 1195, and that even then it may have been on an older foundation; but the tower, transepts, and nave were the work of Symon (about 1226), previously Abbot of Iona, which may partly account for the resemblance to Iona, and the position of the Bishop's Palace adjoining the Cathedral on the north. At a later date the so-called crypt was inserted under the chancel, the floor of which was raised nearly three feet. The north transept arch is Early Decorated, the southern and western arches are later work.

The fine embattled walls (four feet thick) surrounding the islet are said to have been erected by Henry, fourth Earl of Derby, in 1593. The approach has been ruined in appearance by modern quays and cement work, but one may still see some of the rude steps, cut in the solid rock, leading to the portcullis door of the old square tower, which is supposed to be early fourteenth century work.

Godred II. died here in 1187, and King Olave also died at Peel, in 1237. We read of Reginald's descent upon it in 1228, when he burnt Olave's ships and those of all the chiefs of Man. It seems, therefore, that Olave must have had a stronghold here, though now no trace remains, unless the entrance tower is of that date. Our figure (fig. 42), giving a general view of the Castle

with the Round Tower in the distance, is from a photograph by Mr. G. B. Cowen.

Rushen Abbey, on the Silverburn, in the village of Ballasalla and Parish of Malew, dates from the twelfth century, Ivo, Abbot of Furness, having in 1134 received a grant of lands for the purpose from King Olave. Cumming thinks there may have been some sort of a religious house earlier, though there is no notice of buildings in the Chronicon Manniæ (kept by the Monks at the Abbey) till 1192, when it is recorded that the monks were transferred to Douglas for four years, during which

FIG. 42. View of Peel Castle on St. Patrick's Isle, from the town. Photo. by G. B. Cowen.

they were engaged in enlarging the accommodation at Rushen. The Church was not completed and consecrated till 1257. According to Chaloner's drawings, made in the seventeenth century, there were five towers of rude masonry, with square-headed openings. The only decided architectural detail is a plainly chamfered arch in the Church tower, one apparently of an arcade running North from the tower, three others now in the Grammar School, which was the old Church of St. Mary, Castletown,

* Yn Lioar Manninagh, III., p. 405.

having, as argued by the Rev. J. Quine, been removed after the dissolution (1541), when the furniture, ornaments, and building materials were sold and scattered. A small vaulted passage, left standing at what must have been the west end of the Church, may, Cumming thought, have been connected with the crypt. On one of the key-stones of the arch is a socket for the suspension of a hook, perhaps for a corpse-light. Traces of inhumation have been met with in one corner. In this vault have been gathered a few carved stones and other relics recently recovered; also a fine coffin-lid, of which the exact original site is unknown. It is of thirteenth century work, and of interest as being the oldest stone monument of English or Gothic architecture in the Island, and, as marking the end of the old type illustrated by the Celtic and Scandinavian carvings referred to above. It may have been the tomb of Olave the Black, who was buried here in 1237, or of his son Reginald, 1248, or, even more probably, of the last Norwegian King of Man, Magnus, buried in the Abbey in 1265 (fig. 43).

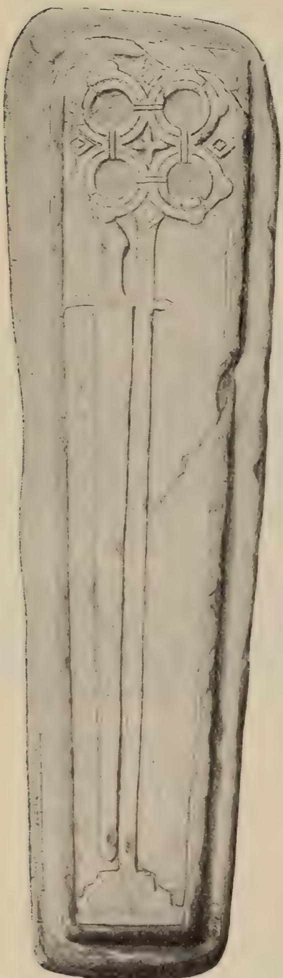


Fig. 43.

A square tower remains at the entrance to the Abbey

grounds, which, on the east, would be well defended by the river, doubtless in those days deeper and at a lower level. An indication of the former level of the ground appears in the Refectory, now converted into a stable, where the tops of the windows appear almost on a level with the present floor.

Near by, at the foot of the mill dam, which may have been raised by the Cistercians themselves, is the "Crossag," an example of a thirteenth century bridge, nearly in the same state as it was left by the builders. Its breadth is just 3ft. 3in. clear in the centre. At the western end is a small subsidiary arch, somewhat of the Carnarvon type, or square-headed trefoil, but an original portion of the

Fig. 44. Encaustic tiles, from Rushen Abbey.

structure, a type of which we have several doorways in Castle Rushen. (One is seen behind the elk in fig. 3.) Some encaustic tiles of perhaps 15th century from Rushen Abbey are shown in fig. 44.

Bemaken Friary in Kirk Arbory (Cairbre), though founded by the Grey Friars in 1373, has scarcely any remains, and none older than the fifteenth century. In the chapel, now a barn, may be seen the arches of the east windows, north door and window, and a south

window—the square-headed trefoil. A wall forming the north gable of the farm house, 4ft. thick, may have belonged to the Refectory.

A few of the Parish Churches, such as Malew, Marown, Lonan, and Maughold show portions of walls, lights, &c., of the twelfth, thirteenth, fourteenth, and fifteenth centuries. In connection with the latter Church is the beautiful standing Cross at the gates (see fig. 45), the only monument of its kind in the Island, evidently of about fifteenth century date, and contemporary with the east window, recently removed, and with some other details found in the course of repairs. It is thus described by the Rev. J. M. Neale, in his Ecclesiological Notes (1848)—"A Third-Pointed erection, very perfect and beautiful. It is raised on four square steps—the stone is octagonal; the capital is adorned with four shields—one the arms of Man, one a mere wheel-tracery, the other two much effaced. From this springs the real Rood, bearing on its four sides our crucified Lord, our Lady and the Divine Infant, St. Bridget kneeling, perhaps about to take the veil, and St. Maughold."

The ruins of two keeils of later date than those already mentioned are well worth preserving. The first, on St. Michael's Isle, near Langness, was in ruins in Chaloner's days (1652-60). It is rectangular, 32ft. by 14ft. 8in. inside; the walls, of large and small stones, being 3ft. thick. At the west end is a single bell turret. The door, of which the jambs are rough blocks of limestone, was on the south, and had a semi-circular head. The east window, one lancet, arched; the north has the head out; the south and west were square-headed, the latter two 12in. wide outside, but with a splay inside to 2ft. 10in. The foundation of the stone altar may be seen under the east windows. The height of the side walls is only 10

FIG. 45. East face of standing cross at Maughold. From photo. by G. B. Cowen.

feet. The graveyard measures 64 yards by 33 (fig. 46).

St. Trinian's, Marown, is at the foot of Greeba, in a meadow by the high road from Peel to Douglas. It measures outside 75 feet by 24; the walls, about 4ft. thick, are built of the local clay-slate, with dressings and quoins of red sandstone, and it is of Early Middle-Pointed style. The east window of two lights, acutely pointed, is 4ft. wide; on each side of the chancel was a one-light window. The priests' door was on the north. The nave appears to have had two one-light windows on the north, and one

FIG. 46. Keeil on St. Michael's Island. From a sketch by Sir H. Dryden.

besides the door on the south. The west window was an ogee-headed lancet, and its gable bears a double campanile. The rubble which supported the altar still remains about a foot high. The Stoup is in the east side of the south doorway, inside. There is a hole in the doorjambs as for a bar (fig. 47).

The finest of all the Manks historic monuments is Castle Rushen (fig. 48). According to the Chronicle, Robert the Bruce laid siege to it in 1313, when Duncan Macdougall

held it against him for more than three weeks. The oldest portions of the existing walls are doubtless the underground chambers of the tower at the entrance. The Keep is of the Edwardian type of concentric castles, as distinguished from the solid square keep of earlier ages; some architectural details point to the middle of the 14th century, but so far neither the exact period nor the builder has been determined. Its height at the entrance is 74 feet, the flag-tower 80 feet from the present surface, which has been filled in to a considerable depth. The thickness of the

FIG. 47. Keeil of St. Trinian, Marown. From a sketch by Sir H. Dryden.

walls is from 7 to 12 feet. At its northern extremity is a lofty portcullis, passing which one comes to an open quadrangular court, with a well in the centre. Outside, at a short distance is an embattled wall 25 feet in height and 9 feet thick, with several square towers at irregular intervals. Exterior to this was a fosse or moat, now filled up, outside of which is the glacis said to have been added by Cardinal Wolsey, when guardian to Edward, third Earl of Derby. On this were three low round towers or redoubts, of which one remains on the north-west side near

the harbour. We are indebted to Mr. G. B. Cowen for the general view of the Castle as seen from the Market Place (fig. 48).

The clock tower was the old chapel of the castle, about 15 feet square. On each side of the oriel window is a stone ledge on which rested the ancient altar; on the south side of it a piscina, and on the north a small niche (an aumbrie, or equivalent of the credence table) for the sacred elements. A small grated window in the north angle appeared to communicate with a cell, conjectured

FIG. 48. View of Castle Rushen from the South. From photo. by G. B. Cowen.

by Mr. Cumming to have been the confessional. The clock, with its curious dial, which hides one of the windows, was a present from Queen Elizabeth, and the bell, as shown by the inscription, was supplied by James, tenth Earl of Derby, in 1729.

Some additions to the buildings were made by James, seventh earl, when Derby House was added as a residence. A stone was found there with the letters D and I C, with the date 1645—James and Charlotte Derby, who resided

here at that date. It would be very interesting and instructive to have a complete plan made of each floor of the castle. Mr. Armitage Rigby is now preparing such

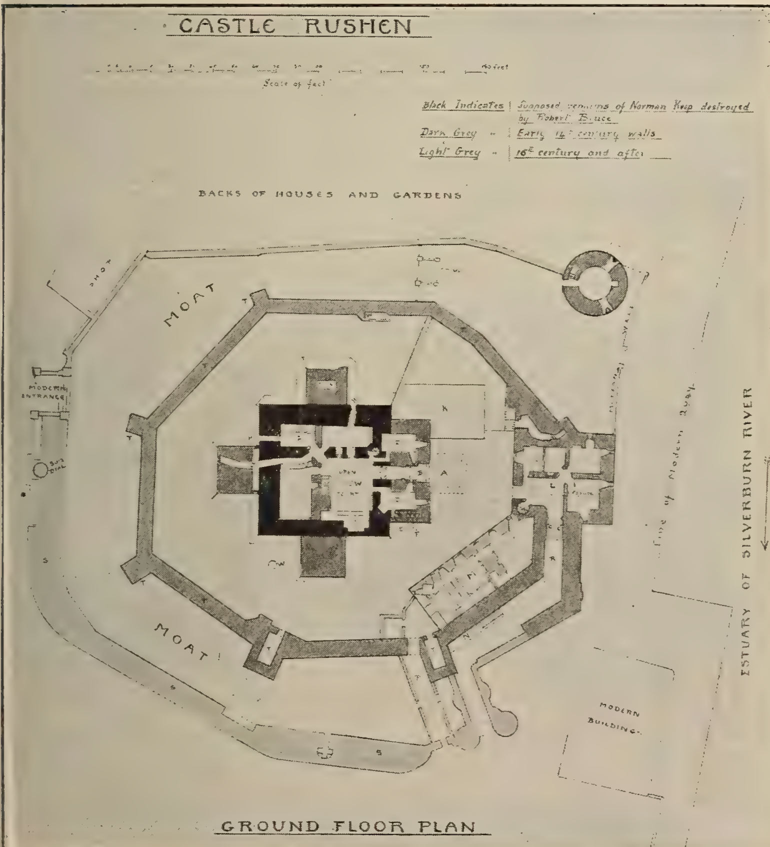


FIG. 49. Plan of Castle Rushen.

plans, and has kindly allowed us to reproduce here that of the ground floor of the castle (fig. 49).

Of camps and small earthworks of the Historic period, besides those of earlier date still in use, the oldest recorded

are those of Magnus, King of Norway (about 1098), of whom we read in the Chronicon Manniæ that he obtained timber from Galloway and from Anglesey and erected many forts in the Isle of Man. That at Baldrine may be an example of this period, with others like it. Some round camps also have been considered Scandinavian in origin, such as that still to be traced at St. Mark's, at the head of the valley where the Silverburn arises, and one which was at Ramsey just north of the Ballure stream, on the brooghs now entirely washed away. Mannan's Chair, in German, and one or two others seem to have been somewhat similar, but on a larger scale: a notable earthwork is that at Lhergyrhenny, on the west slope of Snaefell, known as the Bow and Arrow Hedge. It is 10 feet high on the north side and 15 feet on the south; 12 feet wide at the base and 6 feet at the top. The ditch on the south is 9 feet to 12 feet wide, and can be traced almost right across a neck of land between two deep streams, for about 550 yards.

But the finest of the camps is that encircling the top of South Barrule (formerly Wardfell). On the northern side of the summit are traces of dry stone walls enclosing an irregular area of about 22,000 square yards, the thickness of the base of a wall on the northern side being upwards of nine yards. The approach on this side is an easy ascent; on the south the wall has been much narrower and weaker, and perpendicular to the brow of the cliff, which is inaccessible: it is filled up inside so as to form a raised way or parapet. Some traces of a roadway into the camp are due to the fact that this spot was selected by the officers of the Trigonometrical Survey of Great Britain for the erection of their instruments for connecting with the triangulation of the British Isles.

At Ballachurry, in Andreas, is a fort, probably erected

by James, seventh Earl of Derby, about 1644. It is rectangular, enclosing a space 50 yards by 40 yards. The earthen walls are six yards thick, with four bastions at the corners, all surrounded by a wet fosse of ample dimensions. About the same date was built Fort Loyal, of small size, to command Ramsey Harbour, which in those days would be at the north end of the Mooragh. The low mound of its foundations can still be traced. Probably remains on Gob-ny-Ronnag, Port Lewaigue, and elsewhere round the coast, were then either erected or strengthened and restored to use. On St. Michael's Isle is a circular

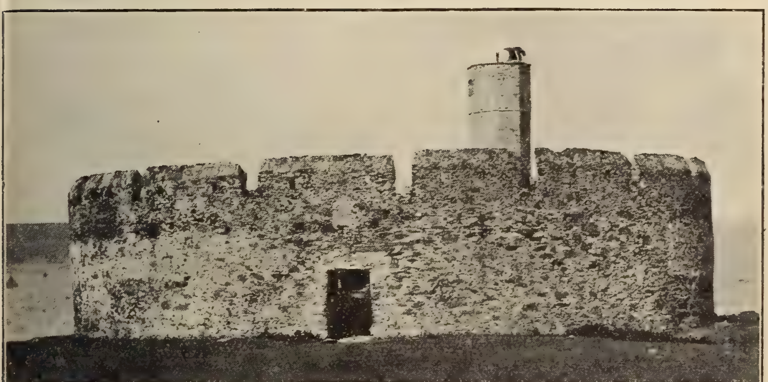


FIG. 50. Derby Fort on St. Michael's Isle. From photo. by G. B. Cowen.

embattled fort of stone, over the doorway of which is carved a coronet, with the date "1647." The walls are 8 feet thick, but not solid; it is badly in need of repair.

Of loose articles of the Historic period some deserve at least a passing notice. We may consider them under the heads of—Weapons, Coins, Furniture, Ornaments, Implements and Utensils.

As regards the first, we have examples of cannon of the time of Henry VIII. and of Charles I. at Peel, and of

Elizabeth at Castle Rushen. At Bishopscourt are two small cannon from ships' longboats taken from Thurot in an engagement off Ramsey at the end of the 18th century, and others in Jurby and Bride are of the same period. Iron swords and daggers from Maughold Churchyard, and a broadsword and spear from Ballaugh village are in the Edinburgh Museum. "A basket-handled sword of great size and battle-axe" were found in a stone coffin in Patrick; swords were found at Glen Meay, and a sword and spear-head at Ballachrink, Jurby, but we do not know where these now are. An iron dagger-handle from Michael is in the collection at Castle Rushen. A pike-staff found in Ballaugh curragh about 1889 is now lost. Very likely other such articles are in private collections of which we have not heard, and many no doubt have been taken off the Island or lost.

At Peel Castle have been found stores of granite cannon balls, most of which have been recognised by Mr. Lamplugh as of Foxdale granite. A few stone, and one or two small iron cannon balls have been found also at Peel and in the north of the Island. The most notable historic weapon is the sword of state which used to be carried in procession before the sovereigns of Man, and is still borne before the Governor in the ceremonies at Tynwald. This was submitted to the authorities at the British Museum and considered to be of the 12th century. It is said to be exactly similar to that on the tomb of King John, and was thus described (Manx Society, vol. XIX., p. 21):—"Near the rest on each side are the arms of Man with armour on the three legs, and in the centre of this is a curious triangle . . . In its present state it is three feet six inches and one-eighth in length, but the point having been at some time broken off by improper usage, it was no doubt some four or five inches longer originally."

ending probably in a sharp point. Our figure 51 is from a photograph taken for us by Mr. T. Keig, of Douglas.

A memorial of the ancient regal rights and prerogatives of the Island exists in its currency, coined and issued by the Lord with the sanction of the Tynwald Court. No notice is recorded of any insular money till 1679, when Governor Murray's copper penny became a legal tender. Subsequently various supplies of coin in copper were issued by the Derbys and the Dukes of Athol. These were stamped with the three legs and motto, and, on the reverse, the Eagle and Child, with the motto, "*Sans changer*," or some other insignia of the Stanleys, with the initials of the reigning Sovereign. The Duke of Athol stamped his copper coinage with the letter A, and a crown on the obverse. Our figure 52 is taken from Plate I. of the Manks Society, Vol. XVII. About 1825, paper cards or tickets, stamped for 1s., 2s. 6d., and 5s. British were legal currency; also copper pence tokens by small bankers in all parts of the country, with one pound notes of private bankers licensed by the Insular Government. Gold and silver coins of Saxons, Danes, Normans, English and Scottish have been found frequently, and it is

FIG. 51.

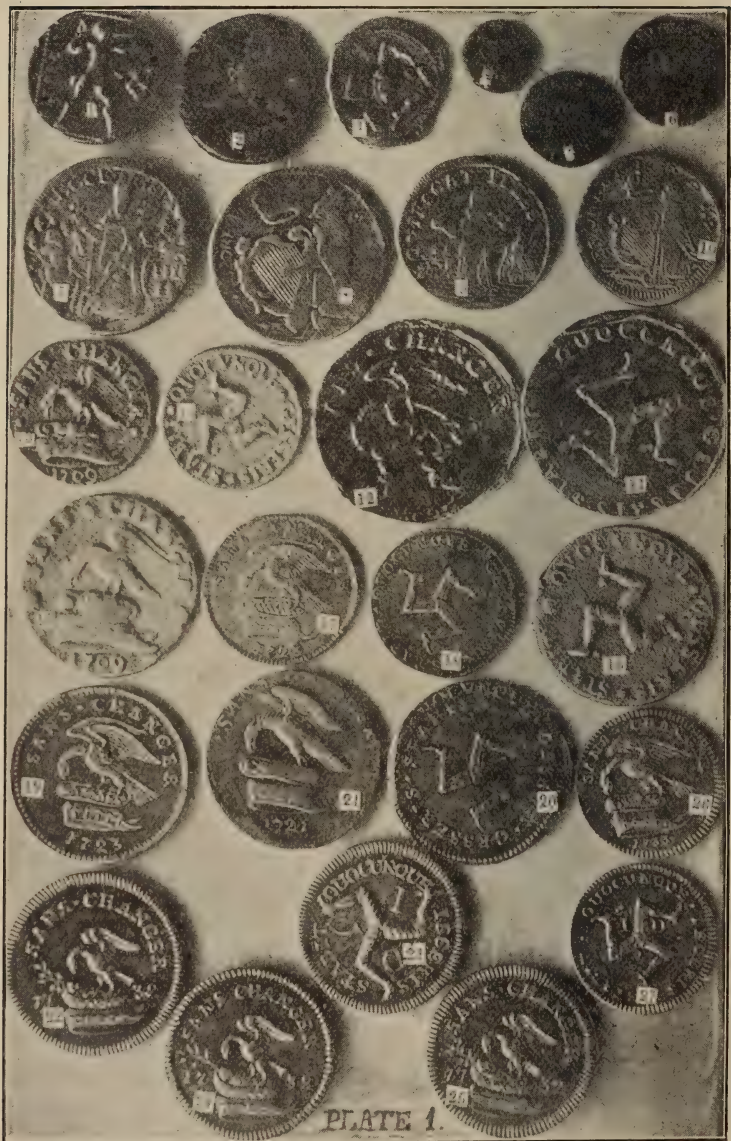


Fig. 52. Samples of Manks coins.

stated that when the Mandevilles from Ireland pillaged the Island in 1315 they carried away large quantities of silver money which they found secreted.*

Under the head of Furniture and Ornaments may be mentioned the stone reliquaries at Peel Cathedral, several rude stone fonts (pre-Reformation), as at Maughold, Bride, Marown, and a beautiful stone holy-water Stoup, 4in. high, and 6in. to 7in. diameter, recently found at a holy well by an ancient keeil on Grenaby, Malew (fig. 53). Very little pre-Reformation Church plate has been

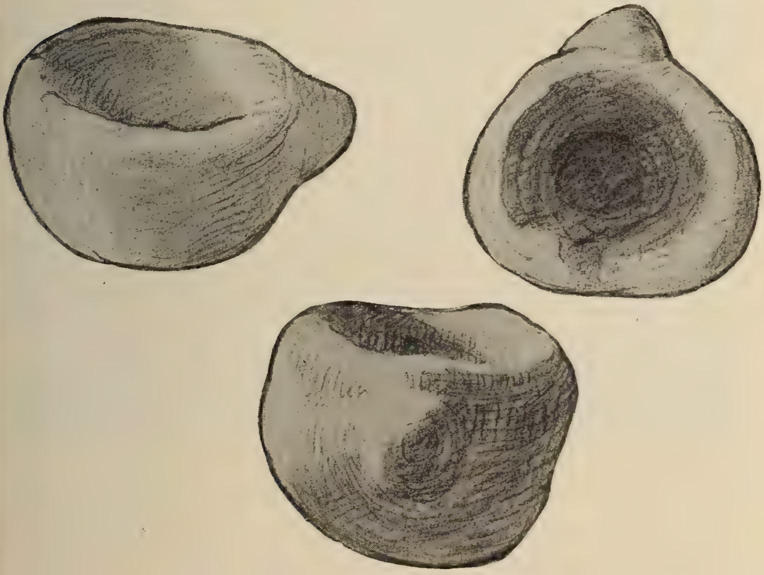


FIG. 53. Stone Holy-water Stoup, at Grenaby.
From a sketch by B. S. Herdman.

found. At Jurby we have a beautiful silver chalice, which was figured and described in the Illustrated Archæologist, January, 1895. The hall-mark shows it to date from 1521; the bowl is broad and shallow, stem plain and

* List of Manks Antiquities. P. M. C. Kermode. Manx Society, XVII.

hexagonal, with hollow chamfered mouldings at the junction with knop and foot; knop of six-lobed type, with angel-marks on the points; the foot is hexafoil, and the vertical edge of the base has a border of leaf and flower design.*

At Malew is a brass Crucifix of the twelfth century, and a silver Paten of 1525. As regards the latter, the Bernicle in the centre instead of an Agnus Dei, or Hand in Benediction, establishes it as pre-Reformation, about 70 others being known to be in existence.

Some encaustic tiles of fourteenth and fifteenth centuries have been found at Rushen Abbey. We figured above some pieces described in "The Reliquary," January, 1885, by the late Ll. Jewitt, Editor (see fig. 44).

Some fragments of stained glass from Peel Cathedral, now in possession of Sir James Gell, have been described in Manx Soc., Vol. XXIX., p. 21. They are chiefly interesting as showing the earliest representation of the three legs.†

A curious wooden Mace in black and gold, now in Castle Rushen, from the collection of the late Mr. Wallace, of Distington, was described by him as having been borne in procession before the Manks Bishops. The remains of a carved oak Rood Screen from the Nunnery Chapel may be seen in the Museum at Castle Rushen. There is also at Arbory Parish Church an interesting inscription by Abbot Ratcliff, carved in oak.

A few gold and silver ornaments have been preserved; some, as a silver necklace and bracelet, found in Andreas, in 1868, and gold and silver rings and bracelets found in Douglas in 1894, having been claimed as Treasure

* Manx Soc., XV., 107-109. Yn Lioar Manninagh, II., 227.

† Excepting perhaps a seal in the British Museum, A.D., 1300. (See Oswald; Vestigia.)

Trove, are now in the British Museum. A few, like the Mylecraine Silver Cross, and the Gold Whistle shaped like a Cavalier's boot, found in the Fort at St. Jude's, are in private hands. No doubt many have been carried away, lost, or destroyed.

Among implements, utensils and household furniture must first be mentioned the querns,* (fig. 54) or hand-mills ("braain"), frequently of granite, which must belong to

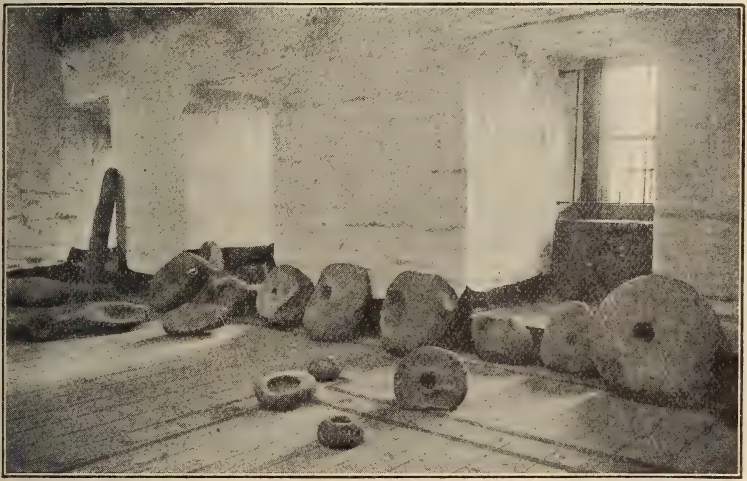


FIG. 54. Manks stone querns in Castle Rushen.

various periods; some have been recognised as probably of the Iron Age, and some, as the "Saddle stones," may be a good deal older.

In later historic times the corn was dried in small kilns attached to the farm. Thrashing was performed with a flail ("soost") composed of two stout and straight branches, fastened together by a thong of

* One of these bears a simple cross-shaped design in low relief.

hide. The portion held in the hands was called "laneraghyn," and the head or part which beat the corn, "slatt-hoost." These have gone out of use within the last twenty years. Two men or women would work together, having a sheaf of corn spread out before them on the floor, which in that spot was made particularly strong and thick, as may still be seen in some old barns. In winnowing a sieve or tray, "Dollan-benalt," was used in the open air. This was made by bending a thin band of wood, the ends overlapping and tied together by means of a tendon run through small holes bored in the wood. Over this was spread a sheep or goat skin, sewn on to the band by cords plaited through the skin and holes in the wood. Being filled with grain this was carried to the door or into a field, a sack or something being spread underneath. The dollan was moved gently backwards and forwards so that the wind might blow the chaff away. In grading the grain, and in the process of meal sifting, similar trays, but perforated, were used, holes being made in the skin by boring with a small red-hot iron bar. The "Peick," very much like the dollan, but smaller and deeper, was used for holding bonnags, cakes, meal, and such like, and was generally kept on the "latts" in the kitchen.

Straw taken from the flail without being broken ("gloyee") was turned into rope, "suggane." Such ropes of straw and hay are still used to secure thatches of cottages and stacks. They are made by "twisters," rods or branches of willow or ash, bent in U-shape, the thicker end elongated and revolving inside a hollow wooden handle. The other end is bent by a string tied to its point, and attached to the first at the point where it enters the handle. A portion of the straw or hay being made fast to the loop, the bent rod is twisted by one man

walking backwards, while the other is engaged in teasing out the hay gradually and evenly.

The long narrow spade used for digging peat is now seldom to be seen. Another implement gone out of use was the push-plough, of which there is a single example in Castle Rushen. This was used for breaking up hard ground before ploughing, much as the grubber is at the present time. Ling-drawers are still to be met with. These resemble sickles, some being toothed, some plain. Blunt sickles also were used for drawing gibbons out of the sand. The "Lister" was a straight-pronged trident used for spearing flukes. Straight-pronged iron forks, or "grips," were made by the local blacksmiths for farm purposes also before the introduction of the modern curved steel forks. These were used also in digging gibbons (the lesser sand-eel, *Ammodytes tobianus*).

In old days the "fidder," or weaver, was an important personage, most parishes having one or more hand-looms, but now the modern mills have taken their place. The old spinning-wheels also are fast disappearing. They all had the "quiggal" or distaff attached to them, so that the same wheel could be used either for flax or wool. Flax, commonly grown in the Island until some 50 years ago, when cut, was left lying for some time in water, then sent to the tuck mill, "Myllin walkee," to have the skin or bark torn off, after which it was combed by a "heckle" into the condition of tow, when it was ready for spinning. Sometimes the carding of flax would be done at home, the heckles used, of which some examples may be seen in Castle Rushen, being exceedingly primitive. A "swift" was required for winding the balls off into hanks, which were then ready for weaving into linen.* The spinning

* See an interesting article by Miss A. M. Crellin, in Yn Lioar Manninagh, Vol. II., p. 265.

of wool for stockings or cloth was somewhat similar, only the quiggal was removed from the wheel, the "rolls" being kept on the knee. After the wool from the sheep had been washed and picked, it was carded with combs, "threden olley," and then, with a quick turn of the wrist, made into short rolls with the back of the combs. When two spools of wool had been spun, they were put on the "clowan broachey," reel bobbin or wheel spools; the spinning wheel being then turned the reverse way, twisted them together into strong "threads," ready for knitting into stockings, or for weaving in the hand-loom into cloth or dress material. If the thread was required in hanks, as it would be for making cloth, a "crosh-lane," hand-cross, would be used; this crosh-lane was made of wood somewhat the shape of an anchor. The thread was put round it and thus formed into hanks. If, again, hanks were required in balls, there was the "chrown thross," winding blade, for that purpose: in shape this was like the sails of a windmill, and, fixed in a wooden stand, revolved in something the same manner. One kind, after 60 revolutions, made a little "clic," showing that a certain quantity of wool was wound, and then started afresh.

With regard to lighting arrangements, an original natural lamp used here until quite recently was the "Tanrogan," or large scallop (*Pecten maximus*), the hollow upper shell of which made a natural saucer in which a wick of rag or rush would lie in solid or liquid grease, sometimes lard, sometimes fish oil, or goose-grease. The "Cruisie" is very rare. It has an oil vessel formed with a spout from which the wick "bitte," projects, and hangs from a hook provided with notches by means of which the vessel can be tipped forward gradually as the oil burns down. A second and larger vessel fixed below is to catch the drippings of the oil. The iron rush and candle holder

(fig. 55) is more common, but fast disappearing. For these, the rushes were cut in the summer, the peel removed excepting a narrow rib running from top to bottom, left to support the pith, and the cores thus obtained dried and bleached in the sun, while the strips of peel were twisted to form lankets for sheep. The cores were then dipped in

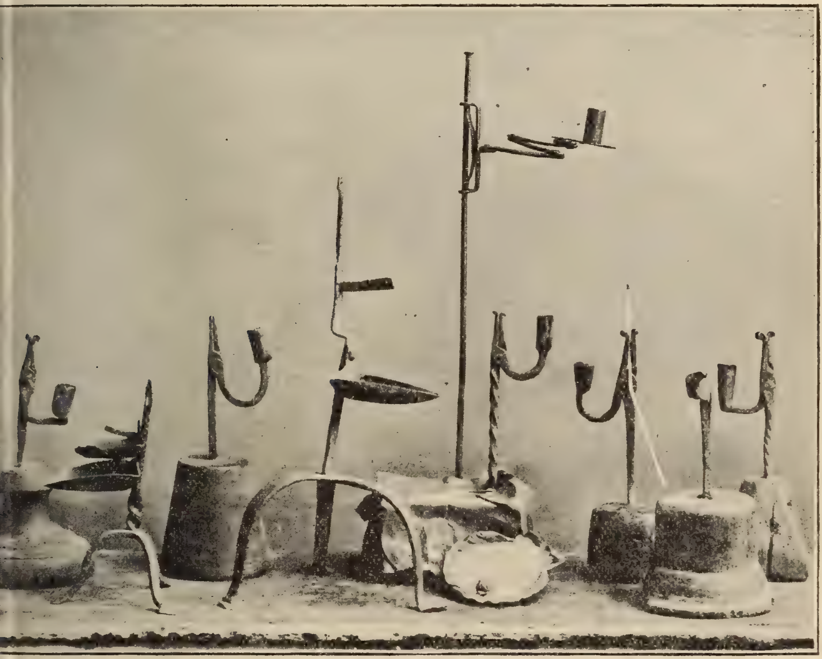


FIG. 55. Old Manks Tanrogan lamp, cruisies and rush-light holders—from a photograph. For the loan of this block we are indebted to the courtesy of the Publisher of "The Antiquary."

scalding grease until thoroughly saturated, and after being allowed to cool were ready for use. The most simple type of iron holder for these rushlights had a thin point of the iron, about an inch long, split off for the purpose. The usual form had the lower end of the iron stand, which was

somewhat pointed, inserted for steadiness into a block of wood, generally cylindrical, or very slightly shaped. The upper end, about an inch in length, formed, with another piece of iron moving on a pivot, the jaws or nippers to hold the rush, the necessary pressure being given by a bent lever and weight at the other end. In a development of this the weight was formed into a ring or socket, which serves also to hold a candle (fig. 55). In general, however, this ring is deepened and the bottom closed. The total height of the holders was generally from nine to twelve inches; sometimes it is set on three or four iron legs instead of in the wooden block. At Orrysdale is a curious spiral form in which the candle was raised or lowered by twisting a pin round and round in the spiral. Sometimes the holders were made to hang from a nail. Later, candles were cast in moulds made by local tinsmiths. These, which are now scarce, were long hollow cylinders tapering to a cone at one end, the tip open to allow the wick to be set centrally in the mould. Later moulds had a funnel-shaped reservoir at the top to prevent the melted tallow from overflowing.

Home-brewed "jough," made in many farmhouses, was kept in deep, narrow, earthenware "crockans," a large wooden plug filled the top, and the beer was drawn off by a smaller one near the bottom, called the "thalbane pluggane." These crockans differed in size and shape, but were all tall and narrow, holding some two or three gallons. The round wooden butter box, taken by the fishermen to "the herrings," would hold a pound of butter. The owner's initials were often roughly cut on the top of the lid with a knife. This and flat cakes, of flour or meal, "berreenyn," baked upon a "losh," or baking-stone, the circular flag placed over a peat fire, were all they would take with them, the rest of their fare con-

sisting of the herrings which they caught. As stated by Waldron (Manx Society, XI., 49), "the first course of a Manks feast is always broth, which is served up, not in a soup dish, but in wooden piggins, every man his mess. This they do not eat with spoons, but with shells, which they call sligs, very like our mussel shells, but much larger." The "piggins" are locally known as "noggins" —tumbler-shaped wooden cans, about four inches high, with one stave left projecting for a handle—in fact, the Scottish "luggie." Horn spoons, about nine and five inches long, were made locally, but are now rarely to be seen. Spoons of lead and pewter were in use until about forty years ago, and several of the moulds are still preserved. They were made by old women, who used to go round the parish carrying their own moulds and crucibles or "cressets." The spoons were about seven inches long, and were made, or "run," at a charge of a halfpenny each. The inside of the mould was smoked in the wick of a tallow candle; this prevented the lead sticking, one smoking being sufficient for six spoons.

It is difficult now to get a pair of "carranes," the shoes worn till about 50 years ago. They were made of tanned, and sometimes of undressed, hide, that of a heifer making about four pairs. The smooth side was worn next the foot. They were turned up all round, and laced at the back of the heel with a thong of hide.

Settles of oak or deal were formerly to be seen in every chimney nook. There was but little carving, sometimes the back was open work, but generally plain. A few oak chests and some old armchairs of the sixteenth to the eighteenth century, are in the hands of private owners, and it would be interesting to have them all figured and described. Miss Christian, Baldromma, whose will was proved within the last few months, has set a

good example by bequeathing such a chair, with the date 1685 carved upon it in bold relief, to Mr. P. M. C. Kermode, for the Manks Museum, in which she knew he took so great an interest. If this example were more generally followed we cannot doubt but that a very interesting collection would be formed illustrating the past history of the Island.

If the foregoing pages in any degree help to the establishment of such an institution as a well-equipped Insular Museum, by arousing interest in it, and by suggesting the character of its collections, so far as Antiquities are concerned, and, perhaps, by inducing our readers to secure for it before it becomes too late such articles as are illustrative of the past history of the Island, we shall feel that this little book has not been published in vain.

FIG. 56. Old type of long Manks cottage. From a sketch by Sir H. Dryden.

YOUNG CROCODILIANS IN CAPTIVITY.

By Dr. J. H. O'Connell.

[Read December 9th, 1904.]

The keeping of crocodilians in private collections, for purposes of study or merely as a hobby, is not as much indulged in as the interest centred in the group would seem to warrant; a common impression among the uninitiated being that crocodiles and alligators (between which genera the general public draws no distinction), are sluggish, uninteresting, and slow.

The term "crocodilian" is applied to a group of highly specialized shielded reptiles, which are divided into six genera. In form they are long and rather narrow, with a flattened cylindrical body, flat head, and long, tapering tail vertically compressed for the last half or third of its length, and usually bearing a serrated crest. This crested tail is their swimming organ, and is of great assistance to them in getting through the water. They have four short legs, the front pair bearing five toes, the hinder ones four; the three inner toes of both pairs only being clawed. The members of this group share, in common with all reptiles, the peculiarity of possessing an exoskeleton of scales. The length of the body measures rather more than the head and neck, and the tail is still longer than head, neck, and body combined. The pupil of the eye is vertical and slit-like. Their mouths are armed with sharp, conical teeth, having hollow bases, which are planted in sockets in the jaws. These teeth are

replaced when lost. There are a number of small teeth within the hollow base of each tooth ready to grow up when the outermost one is lost. In one specimen I observed it was a question of some weeks. Crocodiles have fifteen lower, and seventeen or eighteen upper teeth on each side. Alligators and Caimans have more—seventeen to twenty-two in the lower, and seventeen to twenty upper teeth on each side. Gavials have over a hundred ivories in their mouths.

These creatures are admirably adapted for holding their own in the struggle for existence; their weapons of attack being the jaws bristling with teeth, and the massive powerful tails. The upper surfaces of these reptiles are protected by strong horny shields, underneath which are plates of bone. The armour is arranged in rows of from four to six or eight deep on the back, diminishing over the tails to four rows, of which the two external series unite about half-way down to form the serrated crest. They have also scattered, sometimes keeled, shields on the sides of the body. Under the root of the tail is a longitudinal Cloaca.

They are sensitive to the slightest touch over their heads, dorsal and caudal scutes, and can reach any part of their bodies with their legs for scratching purposes. The limbs have a free range of movement. If food gets fixed between the teeth and cannot be dislodged by shaking, the hinder limb of the same side is brought up and removes it. The head, neck, and upper three-fourths of the body can also be reached by the same legs; the posterior fourth is usually managed by the front pair of limbs. If the cutaneous irritation persists too long, the affected area is vigorously rubbed in a downward direction by the palmar or plantar surfaces. It is interesting to note that the legs can be so turned back that these surfaces

rest downward on the top and sides of the back and tail, when they can rub off anything that clings to them.

The head presents some interesting points. The first is that the nostrils can be closed by a valve action when under water. There is a third and transparent eye-lid for use in the same element, and the opening of the ear can be closed at will.

The cavity of the mouth is very shallow, and they have tremendous crushing powers in their jaws. The palate is grooved for the reception of the tongue, which is always fixed, and in every species is either white or pale yellow. The epiglottis is prolonged upwards and forwards, lying in contact with the palate, thus shutting off the mouth cavity from the gullet and windpipe. The posterior nares open behind this screen enabling the creature to retain prey in its mouth under water without danger of suffocation. All crocodilians are oviparous, the eggs being rough and white, and about the size of a goose egg.

Four of the six genera are fairly frequently met with the true crocodiles, the broad-fronted West African crocodile, the alligators, and the caimans. The remaining genera are, the gavials and a connecting form known as Tomistoma, coming from Borneo, and related to both the Gavials and the crocodiles. These are seldom imported. The former is said to be almost exclusively fish eating.

Crocodiles usually have the fourth mandibular tooth fitting into a notch in the upper jaw; the teeth of both jaws interlock, and the nasal bones, while entering the nasal aperture, do not form a bony septum. Then the teeth in the lower jaw do not number more than fifteen on each side. Needless to say, the quadrate bone is immovably united to the skull. The broad-fronted crocodile is the only species of its genus, *Osteolæmus,* and

has the same number of teeth as the true crocodile. Its fourth mandibulary also fits into a notch in the upper jaw. In these points it is related to the crocodilus genus. However, its upper teeth bite outside its lower ones, as in the alligators and caimans, and it has a bony nasal septum like the alligators.

Alligators and Caimans have the fourth mandibulary tooth fitting into a pit in the upper jaw, and their upper teeth bite outside the lower ones. Alligators have a bony nasal septum. The arrangement of the teeth leaves a series of indentations on the upper and outer surfaces of the lower jaw. Caimans have no bony nasal septum, and their shields are articulated together as well as having bony plates in the dorsal and ventral shields. It should be mentioned that thin ossifications are said to be found in the ventral shields of the Chinese and third species of alligator.

An interesting point in connection with crocodilian teeth is the fact of the first mandibulary ones usually piercing the premaxillæ and shewing superiorly. In a tanned Caiman's skin (*C. sclerops*), measuring eight feet in length, one of the fourth mandibular teeth had bitten through its pit, leaving a mere bridge of bone and integument bridging across what was virtually a notch.

The snout in the young gavial is proportionately much longer than in the adult form. In a young, rough-eyed or spectacled Caiman, the reverse is apparently the case, as this particular specimen's snout has increased in length. In studying a graduated series of *C. niloticus*, ranging in size from a foot up to thirty inches, I have found the proportion of the snout's length increase with growth.*

* In specimens of about 12 or 15 inches in length the ratio the length of snout bears to its basal width is about 1·2 : 1. The ratio increases to 1·3 in specimens of 24 inches.

Crocodilians cannot turn their heads at right angles to their necks. Probably the greatest angle will not be more than 45 or 50 degrees. However, they reach this position very quickly, and by a side swing of their bodies bring their tails round forcibly, allowing prey little chance of escape. These movements are accentuated when caused by hunger or irritation. The young, sharp-nosed crocodile is more supple in all its movements.

In attacking a living object, such as a frog, they try and approach quietly until close; then a short, sudden rush and snap of the jaws settles the question. I have on more than one occasion had my hand bitten and torn by my Egyptian crocodile, almost painlessly, so quick has been the attack. The teeth are buried deeply, but as the creature pulls back or jerks sideways the resulting wounds are always nasty lacerated ones. Their bites do not suppurate, and do not take longer to heal than any other lacerated wound might do.

Of all these reptiles, the Mississippi alligator (Pl. II., fig. 2) is the most frequently imported. It can usually be procured each season from the large dealers, ranging in size from a foot upwards. Specimens under eighteen inches are most suitable, and they make very interesting little pets. The ground colour is black, with deep, yellow transverse bars on the body and tail. On the back the bars cross almost at right angles, while on the sides they are wavy. Their snouts are short, flat, and wide. In disposition they are quiet, and seldom snap, feeding regularly. There are six nuchal scutes longitudinally arranged in three pairs, and about seventeen transverse dorsal rows, the widest containing eight shields. The head is nearly twice as long as broad at its base.

Alligators are always keenly alert, watching any

unfamiliar object with great attention. A pet grey-breasted parraquet (*Myopsittacus*), which is allowed to wander up and down the bars of my crocodilians' tank, attracts considerable notice. It is probable that the motive is less the gratification of idle curiosity than of more sanguinary desires. The alligators raise their heads well above the water and follow the bird's movements keenly, at times making futile jumps in its direction. On one occasion "Polly" was outside the bars near the water, when the smaller one—a specimen thirteen inches long—sprang towards the wires with mouth wide open and eyes gleaming. Polly retreated hastily. One specimen, in particular, shews a marked antipathy to the bird.

They quickly get to know their keeper, and come to the side of the tank when food is presented; in fact, when hungry, they keep repeating their cries with mouths open until fed.

There are three species of alligators, the Mississippi, the Chinese, and one other (*A. helois*), about which practically nothing is known. The Chinese is not often seen over here. Alligators range over North America and China, and reach a length of six or eight feet.

There are eleven species of crocodiles, and their range is much more extensive than that of alligators or caimans. They are found in Africa, America, Australia, and Southern Asia. Three of these are long snouted, heading the list in the West African "Cataphractus." Four have a snout of medium length, *C. niloticus* and *C. americanus*, and the remaining species are short snouted. The long snouted West African crocodile (*C. cataphractus*) ranges from the Senegal to the Gaboon (Boulenger), and, judging from statements made by seafaring men trading at African ports, it is fairly common at Old Calabar. In spite of this fact, it is not frequently imported. The

length of its snout is from two and two-thirds to three and one-third its basal width (Boulenger).

In the specimen figured in Pl. I., fig. 1, which measures 28·25 inches, and from which the following description is taken, the length of the snout is 2·75 times its basal width. The snout is very long and slender, its tip is slightly expanded—becoming contracted at the notches; immediately in front of the latter are two short ridges running obliquely backwards and inwards. The snout is laterally expanded about the level of the fifth or sixth maxillary tooth, contracting again nearer the head.

The colouration of the upper surface is a dark olive, more marked on the head and snout.

There are four small post-occipital scutes, the outer pair of which are somewhat anterior to the inner ones. Behind these are four large nuchals in a square with a smaller pair immediately behind, making it difficult to decide whether they are nuchal or dorsal.

Continuous or sub-continuous with these are about twenty-eight transverse rows, the widest with six in a row. The dorsal armour is very regular. The first seventeen rows of the thirty-four or thirty-five forming the tail are undivided, the remainder form the serrated crest.

There are four, somewhat indistinct, transverse dark bars crossing the back, and two or three similar bars sloping obliquely downwards and backwards, along the sides; in addition to which there are some dark scattered blotches. Three or four heavy dark bars cross the tail transversely, while the sides of it are heavily splashed with black. The under surface of the throat is white, that of the abdomen white also, with black marblings on each shield, and the under surface of the tail is dark brown with white patches.

The lateral surfaces of the jaws shew a few hazy

brown spots. Irides yellow. This species seems quiet, and, although it hisses frequently, makes no attempt to bite. It feeds well, taking fish and meat. It should be mentioned that the gular and ventral shields are bony in the adult (Boulenger).

The Egyptian crocodile, *C. niloticus* (Pl. I., fig. 3), is the best and longest known species. It was the sacred crocodile of the ancient Egyptians. and ranges practically over the whole of Africa. Its distribution is given as extending from the Nile and the Senegal to the Cape, and is also found in Madagascar. Its snout is of medium length, less than twice its basal width, upper surface rough. It has four shields in a transverse line behind its head, and two pairs of larger ones arranged in a square with a smaller one on each side. This last arrangement is common in many crocodilians. The dorsal series comprises about seventeen transverse rows, the widest containing eight longitudinal series. The two outermost ones are irregular. In disposition it is savage, and rather intractable. Its colour is usually yellowish-olive, and has the scales and shields of the upper surface mottled with small dark stripes. The junctions between the scutes are also dark. Four or five broad, dark bands cross the back somewhat irregularly; they are prolonged down and blend near the femurs, the anterior lines running backwards while the posterior slope obliquely forward. The tail has four regular, transverse bars superiorly, while laterally the bars run obliquely backwards and downwards. There are two paired ridges in the upper jaw of the young, the first pair in particular being very noticeable. They arise immediately anterior to the notch for the fourth mandibular tooth, and run obliquely backwards and inwards for a short distance. The posterior enlargements

are less marked than the anterior pair, and occur over the fifth or sixth maxillary teeth, running parallel to the former ones. On the ventral surface of each scale of this crocodile we find a minute spot, not raised, resembling the opening of a pore: it is a sensory pit, and is not seen in *C. cataphractus* or *C. americanus.** One specimen in my collection is peculiar in being very black on the back. It is probably older than its actual size would lead us to believe, as its total length is under twenty-six inches.

The American or sharp-nosed crocodile (*C. americanus,* Pl. I., fig. 2) is another fairly-frequently seen specimen, found in the Southern States, Cuba, and Central America. Its snout measures less than two and a quarter times its basal width, and has a longitudinal ridge on its upper surface. The eyes are rather small, and altogether its build is slighter than most crocodilians. There are usually four nuchal shields in a square; and there are sixteen transverse dorsal rows, the widest containing six shields. Its snout looks much longer than the Egyptian's on account of its slender build, and the shielding on the neck, while resembling the latter's, is less pronounced. The colour of the young is a dirty ochreous yellow, with shields shewing a lighter tint of the same colour. The sides are lighter, and the under surfaces whitish. Across the back are three irregular arrow-head-shaped black marks, pointing forwards, and on each side are six or eight blackish spots. On the upper surface of the tail is a transverse series of alternating blackish and ochreous bars, and its sides are blotched heavily with large dark marks. The irides are light yellow ochre, and the outer and under surfaces of

* M. Boulenger says, in a recent letter: "I do not think there is much in the sensory pits of the ventral shields of young crocodiles, from the species point of view, as I find them quite distinct in some *C. americanus* and absent in some *C. niloticus.*"

the lower jaws are very pale yellowish white. It is pugnacious, but can easily be tamed.

The broad-fronted, or stumpy-nosed crocodile (*Osteolæmus tetraspis*, P. II., fig. 1), is very pretty when small. The ground colour is dull ochreous, the shields dorsal and caudal, and the surface of its head is light umber. It has wide blackish or dark brown bars and large spots. The colour scheme on the back is very irregular, usually one dark bar crosses from side to side obliquely, others unite to form arrow-head marks, pointed forward and not necessarily mesial, others again terminate centrally; large dark spots being interspersed between the bars. The tail is spotted and barred obliquely. The outer surface of the lower jaw is ochreous, with brownish spots a fifth or sixth of an inch in diameter. The eyes are large and prominent, the irides brownish. There is a deep groove between the eyes, snout very short, under surfaces leaden hue, becoming black with age.

Caimans are shyer than any of the preceding species. Their colour scheme shews a tendency to spotting more than barring. The body is slightly longer also. Their heads are short, with raised prominent forehead and eyes. Their snouts are less broad than alligators; the nasal portion is raised into a small hump. They do not become as ravenous feeders. Five species are known, all of which range through Central and South America. The commonest is the rough-eyed, *C. sclerops* (Pl. II., fig. 3). The dorsal surface of the rough-eyed Caiman is a darker ochre, with an abrupt transition to a lighter colour on the sides. Under surfaces yellowish white. The sides are profusely spotted with well-marked black spots quite a fifth of an inch in diameter. The colour scheme on the back consists of four pairs of piriform curved dark marks. These pairs

do not actually coalesce in the middle line, nor are they quite opposite one another. The mesial portions of the marks are about half an inch in width. They curve outwards and backwards, and taper somewhat on the sides, where they slope very obliquely backwards. The neck has a few dark patches on its shields. The last two-thirds of the tail is serrated. On the anterior superior third are three dark bars. The remaining and laterally compressed two-thirds has regular bars running downwards and slightly backwards. Irides dull ochre. There are four paired transverse series of nuchals, and eighteen transverse series, the broadest with ten shields. Colouration fades in every species with growth or age. By the time the Caiman reaches a length of two feet the dorsal marks have become almost obliterated. The upper surfaces are of a dark olive colour, head very dark, the sides and tail yellowish; the latter still shews some bars. Under surfaces a pale grey on the sides, becoming yellow in the centre. They cannot be trusted with smaller specimens. A rough-eyed Caiman, 28 inches long, killed and partly swallowed a small one of the same species ten inches long. On being handled it makes frequent and determined efforts to bite, at the same time hissing and uttering its peculiar grating cry.

I have not had opportunities of determining, satisfactorily, whether age or growth is more responsible for colour fading. Most crocodilians of two and a half or three feet have already assumed, or are assuming, the sombre hue of adult specimens; the earliest change noticeable being a darkening of the ground colour, thus diminishing the contrasts. In the Mississippi alligator less change is required, it is already almost black. The only portions to fade are the dark yellow bands.

Most small crocodiles produce some noise or other. The different species in a tank can be distinguished by their especial calls. The Mississippi alligator has a sharp, short and high-pitched grunt, the broad-fronted crocodile is similar, but less musical and shorter even. The rough-eyed Caiman rarely produces any sound. When it does, it resembles the grating together of dry sticks. The American crocodile has a prolonged lower, and more grumbling note, frequently repeated. The Egyptian's is a deep short sound, like a young puppy's early attempt at a growl. These sounds or calls seem to be indicative of either hunger or satisfaction, and the animals will respond to the human voice when they get used to their keeper. Anger is evinced by a long-drawn hiss, produced by a deep inspiratory effort, the other sounds are expiratory. Very little seems to be known definitely about their rate of growth. One alligator in my possession grew half an inch in length in a calendar month, and in eight weeks it grew one and three-quarter inches, then measuring sixteen and three-quarter inches. An Egyptian crocodile in six or seven months growing about two inches. When first measured this specimen was twenty-five inches long. Their growth in captivity seems to be very erratic. An American crocodile in three months increased one inch in length, then measuring thirteen and a half inches; a small Caiman in three months growing only one inch.

One meal each morning should be enough for most specimens, except in two cases; the first being in very small specimens, when a smaller amount may be given in the evening. The second case would be when there was much disparity in size; then it might be better to avoid leaving a large specimen hungry with small ones perhaps half, or even less, his size.

They can easily be trained to take their food off a

long stick or forceps. This is satisfactory, as it avoids leaving pieces to foul in the water, and, in addition, insures the fact of each specimen getting its proper allowance. Their diet ranges from chopped meat, small fish, sliced fish as procured from the fishmonger, frogs, worms, meal worms, and even cockroaches are relished. Some specimens devour frogs readily; others mouth them, and are deterred from making a meal by the acrid secretion of the amphibian.

As an exclusively meat diet makes their jaws soft, they will require fish once or twice a week at least.

Food is snapped sideways, and is turned in the mouth by a series of jerks, until the longest axis lies in the length of the mouth. It is then gulped down, swallowing being aided by alternate flexion and extension of the neck. Fish, when taken whole, are turned and swallowed head first.

Young crocodilians spend their day climbing and crawling about the tank, but will rest for long periods almost motionless, sometimes with their eyes tightly shut. Crocodiles have a habit of keeping their mouths open in the water. Caimans and alligators prefer sleeping extended full length under water, on the bottom; crocodiles, as a rule, remaining with their backs, eyes, nose, and crest of tail showing over the water. As their existence is normally spent in an amphibious condition, divided between land and water, it is necessary to reproduce conditions in captivity similar to those found in nature.

A galvanised iron tank, two and a half feet by eighteen inches wide and four inches deep, is most suitable. It should have a stopcock or screw cap to allow for emptying. On this tank should fit a cage of wire, the arrangement of the latter being vertical. The separate

wires need not be less than half an inch apart, and the horizontal or binding wires three or four inches from one another. It may be completely open on top with incurved wires, the cage being fifteen or eighteen inches high. With a cage of this class the reptiles cannot climb out. To give them a dry footing, the cage must project twelve or fifteen inches over one end. An oak board resting in a shallow zinc tray at this end will enable them to leave the water when they desire it. A small wire ladder will be of great service to the small ones.

A plain deal table, with a circular opening nine inches in diameter in the middle, will support this structure. Underneath the table, and parallel with the top, should be a shelf for the heating apparatus. Three inches depth of water will be sufficient, and at a temperature of 75 degrees Fahr. While we have no definite data regarding the temperature of the lakes and rivers where these reptiles are found, we may safely conclude it will not be under 60 degrees Fahr. In addition, the external temperature is so much higher than ours that it is necessary to have a rather high temperature for them before they will feed well and remain active and lively.

Gas is probably the most satisfactory method of heating, and the simplest form is the oldest—it consists of applying a flame under the tank directly. For this purpose, the smallest atmospheric gas burner will suffice. Mine is on the bunsen plan, capstan shape. It gave twenty-two side jets, half of which I stopped. This will work admirably in connection with tubing from a burner when there is no direct gas-pipe. The burner should be mounted on a block of wood, with asbestos sheeting intervening to prevent the wood burning. Practice will very soon show how high the gas may be turned. Success with these reptiles is easily attained by a minimum of

trouble. The water will require changing each morning, which can be made the feeding time as well. They may be left to their own resources for the rest of the day. Any-one devoting the small amount of time and trouble to them will find himself well repaid by their interesting ways and mode of life. If crocodiles are kept at a suitable temperature they will all feed when they get used to their new surroundings. Failure is mostly due to too low a temperature of the water.

Crocodiles seem a fairly healthy tribe, taking them altogether. They are not much subject to disease in captivity. Sometimes their toes shew enlargements resembling corns, and the internal structure corresponds in appearance with the external characters. Unlike terrapins and water tortoises generally, they shew no carious disease of their shields. Occasionally, however, the ventral scutes shew this carious condition, and less frequently the dorsals. They will at times refuse food for apparently no reason, but, if left alone, will resume feeding of their own accord.

Explanation of Plates.

Plate I.

Fig. 1. *Crocodilus cataphractus*, Cuvier. 28·25 ins.

Fig. 2. *Crocodilus americanus*, Schneid. 14 ins.

Fig. 3. *Crocodilus niloticus*, Laur. 28 ins.

Plate II.

Fig. 1. *Osteolæmus tetraspis*, Cope. 22 ins.

Fig. 2. *Alligator mississippiensis*, Daud. 21 ins.

Fig. 3. *Caiman sclerops*, Schneid. 13·5 ins.

All figures reproduced from life by photographs by J. H. O'Connell.

PLATE I.

Crocodilus cataphractus.

Crocodilus americanus.

Crocodilus niloticus.

Plate II.

REPORT on the INVESTIGATIONS carried on during 1904 in connection with the LANCASHIRE SEA-FISHERIES LABORATORY at the University of Liverpool, and the SEA-FISH HATCHERY at Piel, near Barrow.

Drawn up by Professor W. A. HERDMAN, F.R.S., Honorary Director of the Scientific Work; assisted by Mr. ANDREW SCOTT, A.L.S., Resident Fisheries Assistant at Piel; and Mr. JAMES JOHNSTONE, B.Sc., Fisheries Assistant at the Liverpool Laboratory.

(With plates, charts and figures in the text.)

CONTENTS.

INTRODUCTION AND GENERAL ACCOUNT OF THE WORK.

OUR first words this year must be those of sorrow and regret for the loss of our late Superintendent of Fisheries, Mr. Robert A. Dawson. This is not the place to attempt an appreciation of Mr. Dawson's character or a summary of his work, but he has been so intimately associated with the Lancashire Sea Fisheries since the beginning that it would be unnatural, even in this purely scientific report, to leave the death of our colleague unrecorded. Members of the Committee are no doubt thoroughly familiar with Mr. Dawson's work as an administrator and as an official;

but those of us who are engaged in the scientific investigations may be allowed to express our sense of the loss sustained, and to testify to the excellence, the accuracy and the usefulness of the work done in connection with our department by the late Superintendent. Although not trained as a scientific man, Mr. Dawson understood and appreciated scientific methods, and did all in his power to help on our investigations. He kept himself informed of the progress of the work, made helpful suggestions and was always ready to take trouble to obtain for us materials or observations that were required. We can look back with gratitude to much friendly intercourse both in the laboratory and at sea.

Although in some respects it is no doubt almost impossible to fill adequately Mr. Dawson's place, as he had a life-long acquaintance with the district and knowledge of its fisheries, still in other respects the Committee are to be congratulated on the new departure they have made in appointing as Superintendent a young scientific man, Dr. J. Travis Jenkins—a distinguished graduate of the University of Wales and lately Lecturer on Biology at the University College of Southampton. Dr. Jenkins is no stranger to us. He was formerly a student of Marine Biology and Fisheries Science in our own laboratories, and while working here in 1900 contributed along with Mr. Johnstone a paper on the statistics of the Mersey shrimping grounds to our Report for that year, and then again in 1902 discussed critically the evidence as to autumn and spring races of Herring. We welcome Dr. Jenkins as a fellow-worker, and hope that by cordial co-operation between our respective departments much will be done to advance the scientific knowledge of the West Coast Fisheries. Dr. Jenkins has kindly given us for this Report a paper upon a subject he has recently been

investigating for the Committee—the official fishery statistics for this district.

Mr. Scott and Mr. Johnstone have been engaged for the greater part of the past year in their usual work, and the present Report contains the usual evidence of their labours. The hatching operations at Piel have been carried on with care and devotion and have resulted, I am convinced, in as successful results as are possible under the existing conditions. Mr. Scott is badly handicapped by the want of an open-air pond, and it is very creditable that he has turned out such a large number of flatfish fry as over thirteen and a half millions, and that the hatching is effected with such a small loss as about 11 per cent. Mr. Scott's detailed account of the work will be found further on.

The next most important part of our work at Piel is probably the provision of practical classes for fishermen. These seem to increase in popularity as the years go on, and this year 130 applications were received for the 45 possible places in the laboratory. The syllabus of work in these classes for fishermen which we published in last year's report proved so useful, that it has been revised by Mr. Johnstone and issued this year as a separate publication with some additional figures. The list of the classes held at Piel given further on in this Report shows that in addition to the classes for Lancashire a similar class for Cheshire fishermen (arranged by Mr. A. T. Wright) met for the first time. A nature-study class for school teachers was also successfully carried on by Mr. Johnstone and Mr. Scott.

For many years past the investigation of the "plankton" or microscopic life floating at or near the surface of the sea, and captured in the tow-nets, has been carried on for this district by my late friend Mr. Isaac

Thompson, a well-known local naturalist. On his death last winter I asked Mr. Andrew Scott to take up that part of the work, and for the last year all the tow-net collections made, not only on the "John Fell" but also by the Liverpool Marine Biology Committee at Port Erin, have been sent to Mr. Scott for examination. The result of his work is given in a separate article below.

The friendly facilities for work given by the Fishery Board for Scotland and by our Committee are mutually beneficial; and once more we are indebted to the courtesy of our Northern neighbours for permission to trawl for large plaice in their closed waters of Luce Bay. Two trips (three days in all) were made to Luce Bay in October and November, 1904, and our naturalists who accompanied the steamer made a number of successful hauls and interesting observations. The results are fully discussed by Mr. Johnstone in a special article below. On the whole they confirm the conclusions arrived at last year, in fact the similarity in results during the three years in which we have made these observations is very satisfactory.

The cases, to which Mr. Johnstone has drawn attention, of the occasional absence or great scarcity of shrimps upon the Blackpool closed ground (and no doubt elsewhere also) emphasises the need which I have often urged in these reports of a special steamer to conduct scientific fisheries investigations (as distinguished from police-work) on the West coast. Such a steamer would naturally take up a point of this kind, search for and follow the shrimps, if necessary, into deep water, and determine where and how they are living. Without a steamer free from other duties it is scarcely possible to solve such problems of distribution. With an administrative steamer it is difficult to do more than take

occasional and scattered observations; and although all observations have their value, and occasional records mount up and may eventually enable us to draw conclusions, still it takes time to accumulate the necessary mass of statistics, and in a district like ours conditions may change so that records are no longer comparable.

Mr. Johnstone gives an account of the marking of living plaice and soles in different parts of the district. The fish are marked with numbers, measured and recorded, so that when a marked individual is caught again its locality and size can be compared with the former record.

It is too soon yet to draw any conclusions, and this is the kind of enquiry in which one would desire to have a considerable mass of statistics before attempting to formulate views. The matter is reported on now simply for the purpose of informing the Committee that the work is in progress.

The study of the parasites and diseases of fishes is a subject of very great importance, which, notwithstanding a certain amount of work during recent years, must still be regarded as in its infancy as an investigation. In our district it was commenced several years ago by Mr. Scott, who reported on the parasites he found in fishes at Piel. Last year we had two valuable papers in the Report by Mr. H. M. Woodcock, of University College, London; and now the subject has passed into the hands of Mr. Johnstone, who treats, in his paper below, of various internal parasites and the abnormal conditions they give rise to. Excepting the Copepoda, which affect the exterior of the body, parasites of fishes may be grouped into three great sections: (1) the Bacteria, which are microscopic plants; (2) the Protozoa, which are minute and very lowly organised animals, and (3) the Worm Parasites

which are larger and more highly organised animals. The last section is again divided into several groups, three of which—the Trematodes, the Cestodes and the Nematodes—contain important fish parasites. Representatives of all these various kinds of parasites have been investigated during the year by Mr. Johnstone in the diseased fishes sent to the Laboratory.

There is another subject sometimes discussed at present in connection with fish diseases, viz., cancer investigation. It has been shown in Dr. Bashford's Report of the Imperial Cancer Research Fund (July, 1904) that cancer is found in practically all groups of the vertebrata, from the fishes up to man. In all these cases, as has been shown by the minute biological investigations of Farmer, Moore, and others, there are cells which in place of behaving like ordinary tissue-cells when they divide, undergo the processes which are characteristic of egg-cells when about to develop into embryos. The cancer may, in fact, in the light of these observations, be regarded as a new individual growing in an abnormal position and causing by its growth a disorganisation of the tissues in which it lies.

From the wide biological point of view it would seem to be a fruitful line of investigation to determine what there is in common between man and the lower animals that can determine these abnormal growths. The cells with the property of reproducing to form new individuals, either normally or abnormally, are, of course, present in both—and not in vertebrates alone, but in all animals and all plants, but that is not enough to explain the matter. These cells may no doubt be the pre-disposing cause, but it must be obvious that an exciting cause is also necessary. What exciting cause, then, can be found common to those cases in all vertebrata, where the repro-

ducing cells are stimulated to growth in abnormal positions?

Environment, including all external conditions, has been ruled out by some writers on this subject because of the width of distribution of cancer in the animal kingdom, and, therefore, the very varied conditions under which it may occur. But surely to do so is to take an unfortunate view of the conditions of the problem. Given the predisposing cause universally present in organisms, those comparatively few cases in which the abnormal processes take place may be regarded as offering us the opportunity of determining what the exciting cause may be which stimulates to, or permits, further action. Cancer research is now a biological and bio-chemical investigation, and any observations upon the environment of abnormal growths in lower animals, or upon the conditions surrounding diseased cells and tissues, may at any time throw light upon the matter.

In last year's Report I had an article on "Sewage and Shellfish," in which I gave and discussed reports from Mr. Dawson on the pollution of mussel beds, and from Mr. Johnstone on their bacteriology. Mr. Johnstone has continued that work during the past year in the form of a bacteriological investigation of the shell-fish beds of the district in relation to pollution by sewage. In his article given below, he deals with the mussel beds of the Mersey and those of the Lune estuary, and for comparison he also gives the results of the examination of deep-sea oysters from pure water. With his general conclusions I entirely agree, although one cannot help regretting that it seems impossible to define any standard of practical purity which might be recognised and permitted in shell-fish sold as human food.

Since the bacteriological outfit has been established

in the Piel Laboratory Mr. Scott has been re-investigating the cleansing of shell-fish from sewage bacteria by means of a current of water, to which Professor Boyce and I drew attention some years ago.

Mr. Scott used mussels taken from a sewage polluted area, and after ascertaining that they contained quantities of sewage bacteria, he exposed them to currents of 1·75, 3·3 and 6 gallons of clean sea water per hour. The results of a number of experiments show a rapid diminution in the number of bacteria as measured by the colonies produced in petri dishes of neutral-red bile salt agar. At the commencement of the experiment the control mussels showed numbers like 1,200, 1,500 and 2,000 colonies, and at the end of 24 and 48 hours numbers like 30, 20 and 10 colonies were found.

Pressure of other work of late has prevented me from writing more than the present Introductory Section of this Report. I shall hope to return to more detailed work in future years when the Ceylon Pearl Oyster Investigation is off my hands. The opportunities and facilities for detailed biological work in connection with the fisheries of the Irish Sea are increasing every year. Recently the new Biological Station at Port Erin, with laboratories, aquarium, hatchery and open-air pond was opened for work, and during the coming year we hope to move into the splendid new quarters provided by the University of Liverpool for Fisheries Research in the buildings of the Natural History Department now approaching completion in Brownlow Street. There we shall have adequate space for both museum and laboratory work, and the necessary equipment will be provided for all the usual lines of biological and fisheries research. This fine new laboratory will permit us to do more, and should stimulate us to do it better.

W. A. HERDMAN.

UNIVERSITY OF LIVERPOOL,
January, 1905.

SEA FISH HATCHING AT PIEL.

By A. Scott.

For some years now our hatching operations have been limited to the incubation of the eggs of plaice and flounders. This is chiefly due to the comparative ease with which the adults can be kept in captivity for lengthened periods. The limited tank accommodation at Piel prevents the keeping of the adults through the summer months. At other hatcheries, provided with large ponds, as at Port Erin, confinement of the spawners from one year to another presents very few difficulties. The method found most practicable at Piel is to collect the adults in the autumn and set them free after the spawning is over. They are thus retained for about eight or nine months. In the winter months there is scarcely any mortality; any deaths that do occur are due to injuries received when the fish are captured. When the spawning season is over and the summer approaches, a high death rate sets in. To prevent this absolute loss to the fisheries, the spent fish are returned alive to the sea, when we are satisfied that no more eggs can be secured from them.

Through the kindness of the Fishery Board for Scotland the Lancashire Fisheries steamer has been allowed to trawl in the closed waters of Luce Bay for adult plaice during the autumn of the past few years. The adult flounders were formerly caught in the Barrow Channel, but since the removal of the Fishery Officers to Knott End, our supply now comes from the Lune and Wyre. The comparatively long distance that the fish have to be brought, especially in a half-decked fishing boat, such as

is in charge of Captain J. Wright, and the uncertainty of the weather, makes the work rather difficult, however. Frequently, after a rough passage, many of the fish are in a dying state when Piel is reached.

At the beginning of the hatchery season of 1904 our stock of fish was represented by 150 plaice and about 200 flounders. A number of the latter, however, proved to be immature and a smaller number of eggs than might have been expected from so many fish, was secured.

On March 1st the plaice commenced to spawn, and the flounders a few days later. The first fertilised eggs were secured on March 9th and the last on May 7th. The spawning season, so far as the hatchery was concerned, practically extended over a period of two months and was of the same duration as the previous year. During the two months one and a quarter millions of plaice eggs were secured, and fourteen millions of flounder eggs. These were incubated in the Dannevig hatchery boxes and yielded thirteen and a half millions of fry. The fry were set free, as in former years, near the centre of Morecambe Bay. There was practically no difference in the periods of incubation from those of the previous year. In March and early part of April the plaice took seventeen days, and the flounders ten days to incubate. Towards the end of the season the plaice have hatched in fifteen days, and the flounders in seven days. The losses during incubation, resulting from all causes, averaged, in the case of the plaice eggs 11·8 per cent. and in the flounders 11·3 per cent.

The following tables give the number of eggs collected and of the fry hatched and set free, on the dates specified:—

Plaice.

		Eggs Collected.	Fry Set Free.		
March	9	20,000	17,500	March	31
,,	14	30,000	26,500	,,	,,
,,	17	35,000	31,000	April	8
,,	21	40,000	35,000	,,	,,
,,	23	40,000	35,000	,,	18
,,	26	55,000	48,500	,,	,,
,,	28	60,000	52,500	,,	,,
,,	30	70,000	62,000	,,	,,
April	1	80,000	70,000	,,	,,
,,	5	75,000	66,000	,,	29
,,	8	75,000	66,500	,,	,,
,,	11	70,000	62,000	,,	,,
,,	14	65,000	57,500	May	3
,,	16	65,000	57,500	,,	,,
,,	18	70,000	62,000	,,	14
,,	20	65,000	57,500	,,	,,
,,	23	50,000	44,000	,,	,,
,,	25	60,000	52,500	,,	,,
,,	27	45,000	40,000	,,	,,
,,	29	50,000	44,000	,,	24
May	2	45,000	40,000	,,	,,
,,	5	45,000	40,000	,,	,,
,,	7	40,000	35,000	,,	,,
Total Eggs		1,250,000	1,102,500	Total Fry	

Flounder.

		Eggs Collected.	Fry Set Free.		
March	9	... 170,000	150,000 ...	March	31
,,	14	... 180,000	159,000 ...	,,	,,
,,	17	... 200,000	177,000 ...	,,	,,
,,	21	... 350,000	310,000 ...	April	8
,,	23	... 500,000	445,000 ...	,,	,,
,,	26	... 400,000	355,000 ...	,,	,
,,	28	... 550,000	487,000 ...	,,	,,
,,	30	... 600,000	532,000 ...	,,	18
April	1	... 800,000	712,000 ...	,,	,,
,,	5	... 850,000	753,000 ...	,,	,,
,,	8	... 850,000	753,500 ...	,,	,,
,,	11	.. 800,000	712,000 ...	,,	29
,,	14	... 900,000	800,000 ...	,,	,,
,,	16	... 850,000	753,000 ...	,,	,,
,,	18	... 800,000	712,500 ...	,,	,,
,,	20	... 750,000	664,000 ...	,,	,,
,,	23	... 700,000	622,000 ...	May	3
,,	25	... 800,000	712,000 ...	,,	,,
,,	27	... 850,000	753,500 ...	,,	14
,,	29	... 750,000	664,500 ...	,,	,,
May	2	... 650,000	578,000 ...	,,	,,
,,	5	... 400,000	355,500 ...	,,	,,
,,	7	... 300,000	266,500 ...	,,	24
Total Eggs		14,000,000	12,426,500	Total Fry.	

Total Number of Eggs 15,250,000

Total Number of Fry 13,529,000

CLASSES, VISITORS, AND EQUIPMENT AT THE PIEL LABORATORY.

By A. Scott.

The Education Committee of the Lancashire County Council voted a sum of money sufficient for forty-five studentships for *bonâ fide* fishermen residing in the administrative County of Lancaster, to be held at Piel, in the spring of 1904. Applications for these studentships were invited early in February. By the middle of March about 130 names had been sent to the Superintendent's Office, or to Piel. The same number of studentships were offered in 1903, and for these 62 applications were received. It is evident, therefore, that a very keen interest is now being taken in these classes.

The forty-five studentship holders were divided into three classes of fifteen men to each, as shown in the following lists:—

Class held February 29th to March 11th.—John Robinson, Flookburgh; William Wright, Flookburgh; William Wright (Pepper), Fleetwood; John Cassidy, Fleetwood; W. H. Leadbetter, Fleetwood; Richard Hadwin, Morecambe; John Gardner, Morecambe; James Swain, Morecambe; Harry Parr, Blackpool; Thomas Bamber, Blackpool; Richard Ball, Banks; Lawrence Brookfield, Banks; Richard Wright, Marshside; Robert Wright (Pen), Marshside; Robert Wright (Dubby), Marshside.

Class held April 11th to 22nd.—William Hulton, Flookburgh; Jonathan Benson, Flookburgh; John Woodhouse, Morecambe; Fred. Bond, Morecambe; John Cocking, Morecambe; Peter Ball, Senr., Fleetwood; Nicholas Wright, Fleetwood; Moses Wilson, Fleetwood; J. R. Parr, Blackpool; John Parkinson, Lytham; W.

Henry Bonny, Lytham; John Abram, Banks; Ruben Robinson, Marshside; John Ball, Marshside; Charles Rigby, Southport.

Class held April 25th to May 6th.—Jas. Edmondson, Roosebeck; Thomas Butler, Baicliff; Jonathan Porter, Ulverston; Thomas Gardner, Ulverston; Joseph Hadwin, Morecambe; Richard Bond, Morecambe; William Swain, Morecambe; Lawrence Wilson, Fleetwood; Thomas Henry Thomason, Fleetwood; Thomas Whiteside, Lytham; Edward Bonny, Lytham; James Johnson, Banks; John Lloyd, Marshside; Richard Ball, Southport; James Caldwell, Southport.

In addition to the classes for Lancashire fishermen, there was also one for the men from Hoylake. The Cheshire County Council made the necessary arrangements through Mr. A. T. Wright, the Chairman of the Finance Committee, and voted money for twelve studentships. This extra class was held March 14th to 25th. The whole of the men were from deep-sea fishing boats. The following are their names:—William Bird, Joseph Eccles, Thomas Eccles, Arthur Cooper, George Dean, W. G. Evans, William Jones, Joseph Jones, George Howsley, Thomas Hughes, W. H. Sherlock, Llewelyn Smith.

A class in Nature Study for School Teachers was held on two week nights and the Saturday afternoons during the last two weeks of April and first week of May. This class was attended by seventeen Head Masters, Head Mistresses and assistants from the schools under the Barrow Education Committee.

The course of study in the Fishermen's classes and the Teachers' class was practically the same as in 1903, and was conducted by Mr. J. Johnstone. At the conclusion of each class the usual vote of thanks to the Educa-

tion Committee of the County Council and the Sea Fisheries Committee was passed.

A few of the Barrow School Teachers who attended the Nature Study courses, and others interested in Marine Zoology, have formed a Marine section in connection with the Barrow Naturalists' Field Club and Literary and Scientific Association, and meet occasionally at Piel.

Representatives from the Lancashire County Council, under the leadership of Mr. James Fletcher, visited the establishment during the second Fishermen's class. The third class was visited by the members of a number of the Lancashire Local Educational Committees, also under the leadership of Mr. Fletcher. The members of the Ramsbottom Urban District Council, under the leadership of their representative on the Committee (Mr. James Ashworth), the St. James' Rambling Club, and the Wesleyan Guild, Barrow, also visited the establishment during the summer. A large number of ordinary visitors have been shown through the Laboratory and tankhouse.

Some important improvements have been made in the Laboratory. These include three new permanent work-tables, with teakwood tops, for the Fishermen's classes. The tables have gas laid on, which was found to be a great advantage in the dark afternoons during the spring and for the Nature Study class in the evenings. An apparatus cupboard, for holding the microscopes, &c., used in the classes; a Hearson incubator, hot-air oven, steam steriliser, and other utensils for Bacteriological work have also been added to the Laboratory equipment.

ON THE TOW-NETTINGS COLLECTED IN THE IRISH SEA.

By A. Scott.

This report deals with the tow-nettings made when the steamer was carrying out various observations in the territorial area under the administration of the Joint Committee, and also when visiting the off-shore fishing grounds between Lancashire and Isle of Man. In addition to the collections taken by the steamer, a fairly regular series of surface gatherings have been made by Mr. Chadwick, at the Biological Station, Port Erin, and are included in the report.

The majority of the collections made by the steamer are from inside the territorial waters, and are fairly representative of the conditions of pelagic life along the whole coast line of the district. Those from the off-shore fishing grounds are naturally less numerous than the in-shore ones. They were obtained on the few occasions when the steamer was engaged on special work outside the district.

The tow-nettings from Port Erin were all taken in the Bay, in the vicinity of the Biological Station. Port Erin Bay, from its position in the centre of the Irish Sea, presents more uniform conditions than the in-shore waters of the mainland. Its salinity is not interfered with, as is often the case of the Ribble and Mersey estuaries, by the outward flow of large volumes of fresh water. There is also less likelihood of the water being contaminated by the deposit of land débris.

An accurate knowledge of the distribution of pelagic or other organisms can only be obtained when observations are carried out with fair regularity over a wide area. It is well known that animals and plants though pre-

vailing in abundance in one area, may be very scarce, or altogether absent, in another. Their habit being strictly limited to particular regions, even in such a comparatively small area as the Irish Sea. To give one example. The protozoan, *Noctiluca miliaris*, is found year after year, sometimes in enormous numbers, especially during the summer months, in the in-shore waters along the Lancashire and North Wales Coasts. In some years it extends as far out as the Morecambe Bay and the Liverpool North-west Lightships. Notwithstanding this abundance in the in-shore waters, the organisms does not appear to reach Port Erin, nor can we find any record of its occurrence in the Clyde.

It has been found convenient in the present report to group the in-shore collections made by the steamer into a number of sections. Each section represents a definite portion of the territorial waters. The gatherings made on the off-shore fishing grounds are classed under stations I., II. and III. I. and II. are the stations shown on the sketch chart of the district prepared by the late Mr. Dawson; III. is marked by the position of the Liverpool North-west Lightship. The Port Erin tow-nettings form a group by themselves.

Section I.—Blackpool Closed Ground.

Characteristic Organisms.

February .. *Sagitta*, Copepoda and Copepod nauplii.

April ... Copepoda, Isopoda, larval shrimps, Barnacle nauplii, and two species of fish eggs.

May ... Copepoda, larval shrimps, "Ostracod" stage of Barnacle, and five species of fish eggs.

June ... *Pleurobrachia*, *Sagitta*, Copepoda, Crab Zoea and Megalopa, "Ostracod" stage of

Barnacle, young mussels and two species of fish eggs.

July ... Gelatinous algæ, Copepoda, and "Ostracod" stage of Barnacle.

August ... Diatoms, *Noctiluca*, *Sagitta*, Copepoda, Crab Zoea and Megalopa, young *Mysis*.

Biddulphia was the only diatom noted. The Copepoda were represented by *Calanus*, *Pseudocalanus*, *Paracalanus*, *Temora*, *Centropages*, *Acartia* and *Anomalocera*. The Isopoda by *Eurydice* and *Idotea*. In addition to the conspicuous organisms noted above, the following were found during the detailed examination, *Ceratium tripos*, young medusoids, "pluteus" stages of *Echinus* and *Spatangus*, larval worms, the "mitraria" stage of Polyzoa, and one specimen of the second larval stage of the Norway lobster.

Section II.—Ribble Estuary.

Characteristic Organisms.

March ... *Sagitta*, Copepoda, larval shrimps and *Mysis*, and six species of fish eggs.

May ... *Sagitta*, Copepoda, larval shrimps and *Mysis*, "Ostracod" stage of Barnacle, Medusoids, and two species of fish eggs.

June ... Gelatinous algæ, *Pleurobrachia* and Medusoids, Copepoda, Crab Zoea and Megalopa, "Ostracod" stage of Barnacle, two species of fish eggs and one post-larval *Cottus*.

July ... Gelatinous algæ, *Noctiluca*, larval Echinoderms, Copepoda, Crab Zoea and Megalopa, young mussels and one species of fish egg.

August ... Diatoms, Gelatinous algæ, *Noctiluca*, *Pleurobrachia* and Medusoids, larval Echino-

derms, *Sagitta*, Copepoda, Isopoda, Crab Zoea and Megalopa, larval shrimps and *Mysis*, *Oikopleura*.

September. *Pleurobrachia* and Medusoids, *Sagitta*, Copepoda, Crab Megalopa, larval shrimps and *Mysis*.

October ...Diatoms, *Noctiluca*, *Sagitta*, Copepoda, Cladocera, Crab Zoea and Megalopa.

The diatoms noted in this section were *Rhizosolenia*, *Coscinodiscus*, and *Chætoceros*. The Copepoda recorded in the previous remarks were also found in the Ribble estuary along with the following additional species, *Labidocera*, *Isias* and *Euterpina*. The Cladocera were represented by *Podon intermedium*.

Section III.—Mersey Estuary.

Characteristic Organisms.

December.. (1903). *Sagitta*, Copepoda, Isopoda, and larval *Mysis*.

February .. (1904). *Sagitta*, Copepoda.

June ... Gelatinous algæ only.

July ... Gelatinous algæ, *Noctiluca*, and Copepoda.

August ... Gelatinous algæ, *Noctiluca*, *Pleurobrachia*, and Medusoids, larval Echinoderms, *Sagitta*, Copepoda, Isopoda, Crab Zoea and Megalopa, larval shrimps and *Mysis*, *Oikopleura*.

September. Diatoms, *Noctiluca*, *Pleurobrachia* and Medusoids, *Sagitta*, Copepoda, Isopoda, Crab Zoea and Megalopa, larval shrimps and *Mysis*.

The diatoms observed were similar to those in section

II., with the exception that *Chætoceros* was absent and *Biddulphia* present. All the Copepoda noted above were found. *Eurydice* was the only representative of the Isopoda.

Section IV.—Rhyl to Great Orme's Head.

Characteristic Organisms.

December.. *Sagitta* and Copepoda.

February .. *Sagitta*, *Autolytus*, Copepoda, Crab Zoea, and one species of fish egg.

March ... Diatoms, *Acanthometra*, *Sagitta*, *Autolytus*, Copepoda, Copepod nauplii, Crab Zoea, larval shrimps, Barnacle nauplii, Tunicate eggs, *Alcyonium* eggs, and three species of fish eggs.

April ... Copepoda, Isopoda, Copepod nauplii, Crab Zoea, larval shrimps, Barnacle nauplii and "Ostracod" stage, four species of fish eggs.

June ... Gelatinous algæ.

July ... Gelatinous algæ.

August ... Diatoms, *Noctiluca*, *Pleurobrachia*, *Sagitta*, Copepoda, Cladocera, Copepod nauplii, Crab Zoea and Megalopa, larval shrimps, *Oikopleura*, and one species of fish egg.

October ... Diatoms, *Noctiluca*, *Sagitta*, Copepoda, and Crab Megalopa.

Four species of Diatoms were observed in this area, viz., *Rhizosolenia*, *Coscinodiscus*, *Biddulphia* and *Chætoceros*. *Acanthometra*, a radiolarian, was plentiful in February. The Copepoda were similar to those found in Section II., with the exception that *Labidocera* was absent and *Oithona* present. The Cladocera were represented by *Podon intermedium* and *P. leuckarti*.

Section V.—Great Orme's Head to Red Wharf Bay.

Characteristic Organisms.

December.. *Sagitta* and Copepoda.
January ... *Sagitta* and Copepoda.
March ... *Sagitta*, *Autolytus*, Copepoda, Crab Zoea, larval shrimps, and two species of fish eggs.
June ... Gelatinous algæ.
July ... Gelatinous algæ.
August ... Gelatinous algæ, Diatoms, *Noctiluca*, *Pleurobrachia*, and Medusoids, *Sagitta*, *Tomopteris*, Copepoda, Copepod nauplii, Crab Megalopa, and larval shrimps.
September. Diatoms, *Noctiluca*, *Pleurobrachia*, *Sagitta*, *Autolytus*, Copepoda, Isopoda, Crab Zoea, and Megalopa, larval shrimps and *Mysis*, one young gurnard.
October ... Diatoms, *Noctiluca*, *Sagitta*, Copepoda.

The Diatoms recorded for the previous Section were all noted here. The Copepod were similar to the last, except that *Isias* was absent.

Section VI.—Tremadoc Bay.

Characteristic Organisms.

February .. *Sagitta*, *Autolytus*, Copepoda, Isopoda, larval *Mysis*, and two species of fish eggs.
April ... Diatoms, *Sagitta*, Copepoda, Copepod nauplii, Barnacle nauplii and "Ostracod" stage, two species of fish eggs.
May ... Diatoms, *Sagitta*, Copepoda, Cladocera, Crab Zoea, larval shrimps, "Ostracod"

stage of Barnacle, two species of fish eggs and one post-larval gadoid.

June ... Gelatinous algæ, *Pleurobrachia* and Medusoids, *Sagitta*, Copepoda, Crab Zoea, larval shrimps, and two species of fish eggs.

July ... Gelatinous algæ, Copepoda, Cladocera, Isopoda, Crab Zoea and Megalopa, larval *Jaxea*, young mussels, one species of fish egg, and one young garfish.

September. *Sagitta*, Copepoda, Copepod nauplii, Crab Zoea and Megalopa.

Coscinodiscus and *Biddulphia* were the only diatoms noted. *Oithona* and *Euterpina* appeared to be absent, but the others already mentioned were found. The Cladocera were again represented by *Podon intermedium* and *P. leuckarti*. A number of specimens of "Trachelifer" stage of *Jaxea* were found at the surface and bottom in July.

Section VII.—Aberystwyth to New Quay.

Characteristic Organisms.

February .. *Sagitta*, *Autolytus*, Copepoda, larval *Mysis*, and two species of fish eggs.

June ... Gelatinous algæ, *Pleurobrachia*, *Autolytus*, Copepoda, Copepod nauplii, Crab Zoea and Megalopa, larval shrimps, one species of fish egg and eight "Mackerel Midges."

July ... Gelatinous algæ, Medusoids, Copepoda, Crab Zoea and Megalopa, larval shrimps, one species of fish egg, and one young Gadoid.

August ... *Pleurobrachia*, Copepoda, Isopoda, Crab Zoea and Megalopa, larval *Mysis*, larval *Squilla*, one young gurnard and two young weevers.

No diatoms were seen in this Section, but this is probably due to the fact that collections were not made during the periods when they were abundant in other parts of the district. All the Copepoda already given occurred in the Section. Specimens of a larval Stomatopod were found for the first time in our experience of Irish Sea tow-nettings. The pelagic eggs of fish were taken in a tow-netting off the Patches Buoy on February 2nd, the earliest record in the district for 1904. I have just heard from Dr. Jenkins, the Superintendent, that two pelagic eggs and a spent-female fish, 19½ inches long, were collected on January 26th, 1905. Three *Nyctiphanes* and two *Crangon nanus* occurred in the bottom tow-net in February.

OFF-SHORE STATION I.—MORECAMBE BAY LIGHTSHIP.

Characteristic Organisms.

February ..	*Sagitta*, *Autolytus*, Copepoda, *Nyctiphanes*, and one species of fish egg.
March ...	*Sagitta*, *Autolytus*, Copepoda, and Copepod nauplii, Crab Zoea, and four species of fish eggs.
April ...	*Sagitta*, Copepoda, Crab Zoea, "Ostracod" stage of Barnacle, and one species of fish egg.
July ...	Gelatinous algæ and one species of fish egg.
September.	Diatoms, *Sagitta*, Copepoda, Crab Zoea and Megalopa, Medusoids.

Coscinodiscus was the only representative of the diatoms. The Copepoda noted were *Calanus*, *Pseudocalanus*, *Paracalanus*, *Temora*, *Centropages*, *Acartia*, *Anomalocera*, *Oithona* and *Thalestris krohnii*. *Nyctiphanes* was found at the surface in February, and at the bottom in February, March, and April. Three *Hippolyte*

pusiola were taken in the bottom net in February. One *Crangon nanus* and *Pasiphea sivado* at the bottom in March. The Copepod *Thalestris krohnii* was represented by seventeen specimens taken in the surface net in April.

Off-Shore Station II.

Characteristic Organisms.

December.. *Sagitta* and Copepoda.

February .. *Sagitta*, Copepoda, *Nyctiphanes*, *Rossia* and two species of fish eggs.

September. Larval Echinoderms, *Tomopteris*, Copepoda, Isopoda and Crab Megalopa.

No diatoms were noted. The Copepoda were similar to those of Station I., except that *Thalestris* appeared to be absent. *Nyctiphanes* occurred at the surface and bottom in February, at the bottom only in September. *Crangon nanus* was taken in the bottom net in February and September. The Ostracod *Philomedes interpuncta* was noted in the bottom tow-netting in September. Two specimens of *Rossia* were collected at the surface in February. The larval Echinoderms mentioned above were represented by young brittle starfish, which were taken in the surface and bottom nets.

Off-Shore Station III.

Characteristic Organisms.

February .. *Sagitta*, *Autolytus*, Copepoda, and one species of fish egg.

March ... *Sagitta*, *Autolytus*, Copepoda and four species of fish eggs.

April ... *Sagitta*, Copepoda, Crab Zoea, Ascidian eggs and one species of fish egg.

September. Diatoms, *Sagitta*, *Autolytus*, Copepoda, larval Echinoderms, Crab Zoea and Megalopa.

Coscinodiscus was the only representative of the Diatoms. The Copepoda were similar to those recorded for Station II., with the addition of *Isias*. *Nyctiphanes* was present in the bottom net in April. The Echinoderms consisted of young brittle starfish at the surface only.

Port Erin, 1903.

Characteristic Organisms.

April ... Diatoms, *Sagitta*, Copepoda, Copepod nauplii, Barnacle nauplii, and one species of fish egg.

May ... Diatoms, *Sagitta*, Copepoda, Cladocera, *Oikopleura*, Medusoids, Copepod nauplii, Barnacle nauplii and "Ostracod" stage, larval shrimps, and five species of fish eggs.

June ... Diatoms, Gelatinous algæ, *Sagitta*, Copepoda, Cladocera, *Oikopleura*, Medusoids, Copepod nauplii, "Ostracod" stage of Barnacles, and five species of fish eggs.

July ... *Sagitta*, *Tomopteris*, Copepoda, Cladocera, *Oikopleura*, Medusoids, Crab Zoea and Megalopa, four species of fish eggs.

August ... *Pleurobrachia*, *Sagitta*, Copepoda, Medusoids, Copepod nauplii, and three species of fish eggs.

September. Diatoms, *Pleurobrachia*, *Sagitta*, *Autolytus*, *Tomopteris*, Copepoda, Crab Zoea and Megalopa, larval shrimps, Medusoids.

October ... Diatoms, *Pleurobrachia*, *Sagitta*, Copepoda.

November. Diatoms, *Sagitta*, Copepoda, Crab Zoea, larval worms and *Oikopleura*.

December.. Diatoms, *Pleurobrachia*, *Sagitta*, Copepoda, *Oikopleura*.

Coscinodiscus and *Biddulphia* were the diatoms found. All the Copepoda already mentioned, with the exception of *Labidocera* and *Euterpina* were present. *Podon leuckarti* represented the Cladocera.

Port Erin, 1904.

Characteristic Organisms.

January ... Diatoms, *Sagitta*, *Tomopteris*, Copepoda, and Alcyonium eggs.

February .. Diatoms, *Acanthometra*, *Sagitta*, Copepoda, larval Echinoderms, *Oikopleura*, "Mitraria" larvæ, Ascidian eggs, and one species of fish egg.

March ... Diatoms, *Sagitta*, Copepoda, Medusoids, larval Echinoderms, Ascidian eggs and three species of fish eggs.

April ... Diatoms, *Sagitta*, *Autolytus*, *Tomopteris*, Medusoids, *Oikopleura*, larval worms, Copepoda, Copepod nauplii, Crab Zoea, larval shrimps, Barnacle nauplii, and two species of fish eggs.

May ... Diatoms, Gelatinous algæ, *Pleurobrachia*, *Sagitta*, *Autolytus*, Copepoda, Cladocera, *Oikopleura*, Alcyonium eggs, "Mitraria" larvæ, Copepod nauplii, Crab Zoea, larval shrimps, and five species of fish eggs.

June ... Diatoms, *Pleurobrachia*, and Medusoids, *Sagitta*, *Autolytus*, *Tomopteris*, Copepoda, Cladocera, Crab Zoea, larval shrimps, seven species of fish eggs, young Gadoids and one young yellow gurnard.

July ... *Pleurobrachia* and Medusoids, *Sagitta*, Cope-

poda, Cladocera, and two species of fish eggs.

August ... *Sagitta*, Copepoda, *Oikopleura*, Medusoids, Copepod nauplii.

September. Diatoms, *Sagitta*, *Tomopteris*, Copepoda, Cladocera, *Eurydice*, *Oikopleura*, Copepod naúplii and larval shrimps.

The whole of the Diatoms previously given were present at different times of the year. *Labidocera* was the only Copepod out of the names already mentioned that appeared to be absent. No Cladocera were found till the end of May.

Occurrence of Pelagic Fish Eggs.

The following is a short account of the distribution of pelagic fish eggs during the year 1904, with the precise date of their occurrence:—

Plaice. These were the first eggs met with, and were noted as early as February 2nd from In-shore Section VII. On February 10th they were taken at Off-shore Station I., on the 18th at Station III., on the 20th, 22nd, and 23rd at Section VI., on the 23rd at Section VII., for the second time in the month, on the 24th at Section IV., and on the 29th at Off-shore Station II. During March they were taken at Port Erin on the 2nd, at Section V. and Off-shore Station III. on the 3rd, at Station I. on the 9th, at Section II. on the 10th, and at Off-shore Station I. again on the 14th. Plaice eggs were, therefore, present in the Irish Sea during the whole of February and first half of March.

Dab. The first record of the eggs of this fish is from Port Erin, on March 2nd. They were next noted on the 10th and 23rd at Section II. In April they were found in Section I. on the 14th, and at Section IV. on the 28th. In May, at Port Erin only on the 4th. On June 27th, Port Erin; July 4th and 16th, Port Erin.

Occurrence of Pelagic Fish Eggs.

The following table shows the distribution, month by month, in four divisions of the Irish Sea, of the species named:—

In Territorial Waters from Blackpool to Red Wharf Bay.

Months.	Plaice.	Dab.	Flounder.	Brill.	Turbot.	Lemon Sole.	Megrim.	Scald Fish.	Norwegian Top Knot.	Solenette.	Cod.	Haddock.	Whiting.	Bib.	Rockling.	Gurnard.	Dragonet.	Weever.	Sprat.
February	+	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...
March	+	+	+	...	...	...	...	...	...	...	+	+	+	...	+	...	...	...	...
April	...	+	...	+	...	...	...	...	...	+	...	...	+	...	...	...	...	...	+
May	...	...	+	+	...	...	...	...	...	...	...	...	+	...	+	...	...	...	+
June	...	...	...	...	...	...	...	+	...	+	...	...	...	...	+	...	...	...	+
July	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...
August	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...

In Territorial Waters from Tremadoc Bay to New Quay.

Months.	Plaice.	Dab.	Flounder.	Brill.	Turbot.	Lemon Sole.	Megrim.	Scald Fish.	Norwegian Top Knot.	Solenette.	Cod.	Haddock.	Whiting.	Bib.	Rockling.	Gurnard.	Dragonet.	Weever.	Sprat.
February	+	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...
March	...	...	...	...	...	...	...	...	...	...	...	...	...	...	+	...	...	...	...
April	...	...	...	...	...	...	...	...	...	...	...	...	+	+	...	...	...	...	...
May	...	...	...	+	...	...	...	...	...	+	...	...	...	...	...	...	...	...	...
June	...	...	...	+	...	...	...	...	...	...	...	...	...	...	...	+	...	...	+
July	...	...	...	...	+	...	...	...	...	+	...	...	...	...	...	...	...	...	...

On Off-shore Grounds, N.W. of Piel to Liverpool N.W. Light Ship.

February	+										+								
March	+		+								+	+	+						
April																			+
July																		+	

In Port Erin Bay, 1903.

April		+																	
May					+				+						+		+		
June				+	+				+						+		+		
July					+										+	+			
August					+										+			+	

In Port Erin Bay, 1904.

February											+								
March	+	+									+								
April					+						+								
May		+	+				+					+							
June		+			+	+			+	+			+		+				
July		+													+				
August																			

Flounder. The eggs occurred in five of the areas. On March 10th at Section II., on the 28th at Off-shore Stations I. and III. On May 4th at Section I. and at Port Erin.

Brill. The eggs of this fish were found in Section IV. on April 28th, in Section I. on May 9th, and in Section VI. on the 10th. In Section VI., again on June 1st and 26th.

Turbot. The first record of these eggs is from Port Erin on April 19th. They were taken again on June 22nd. On July 14th they were found in a tow-netting from Criccieth, in In-shore Section VI.

Lemon Sole. The eggs were only found once, and were in a tow-netting taken at Port Erin on June 27th.

Megrim. Also noted on one occasion only, at Port Erin on May 4th.

Scald Fish. The eggs were found in the tow-netting from Section I., Blackpool closed ground, on June 10th.

Solenette. Eggs of this fish occurred in the collection taken in Section IV. on April 28th, in Section VI. on May 10th, in Section II. on June 9th and 20th, and at Port Erin on June 22nd. In Section VII. on July 15th.

Norway Topknot. Eggs, identified as probably belonging to this fish, were taken at Port Erin on June 4th. They were also found in Port Erin tow-nettings taken during 1903, on May 11th and 23rd and on June 22nd.

Cod. The first record of the eggs of this fish during 1904 is from the Port Erin tow-netting taken on February 4th. They were also present in the collection taken on the 10th. In March the eggs were found at Port Erin on the 2nd, Off-shore Station III. on the 3rd, Off-shore Station I. on the 9th, Section I. on the 10th, Off-shore Station I. again on the 14th and 28th. In April, they were taken at Port Erin on the 19th.

Haddock. The eggs were noted in five divisions. In

Section II. on March 23rd, Section IV. on the 27th, and Off-shore Stations I. and III. on the 28th. During May they occurred at Port Erin only on the 4th and 26th.

Whiting. Eggs of this fish were taken in Section IV. on March 27th, and in Off-shore Station III. on the 28th. In Section VI. on April 12th, in Section I. on the 14th, and at Port Erin on June 4th.

Bib. The eggs were only taken once during the year, and were in a tow-netting from Section VI., collected on April 12th.

Rockling. Eggs corresponding in size and characters to those of one of the rocklings occurred frequently. They were noted in Section VI. on February 20th, 22nd and 23rd, in Section II. on March 2nd, Section V. on the 3rd, and in Section IV. on the 27th. In Section I. on May 4th, Section II. on the 6th, and in Section I. again on the 9th. In Section I. on June 10th, and at Port Erin on the 27th. At Port Erin on July 4th and 16th.

Gurnard. During 1904, the eggs were only observed on one occasion, and that in a tow-netting from Section VII. on June 26th. They were noted from Port Erin on July 17th, 1903.

Dragonet. The characteristic eggs of this fish have, so far, only been seen in tow-nettings from Port Erin. In 1904 they were found on May 4th, but during 1903 they were obtained on May 6th, 19th and 23rd, and on June 3rd.

Weever. The eggs of *Trachinus* were noted in a tow-netting from Off-shore Station I. on July 21st, and from Section IV. on August 3rd. They were also found at Port Erin on August 11th, 1903.

Sprat. The eggs of sprat were found at the surface in Off-shore Stations I. and III. on April 26th, and in Section IV. on the 28th. In Section II. on May 6th, and

in Section I. on the 9th. In Section VI. on June 1st, in Section II. again on the 9th.

Halibut (?). The occurrence of three specimens of a very large pelagic fish egg near Ballantrae Bank, in the Firth of Clyde, in a tow-netting taken by the Lancashire Fisheries steamer, has already been referred to in a previous report.* From the size of the egg, over three millimetres, it was suggested that they might belong to the halibut. The larvæ hatched out, and were preserved, but, unfortunately, no drawings were made of the live fish. The preserved specimens were shown to Dr. A. T. Masterman some time ago, and he concurred with our suggestion that the larvæ were probably young halibut. Two drawings of one of these larvæ (Text-fig. 1) are now given with this report, in the hope that further light

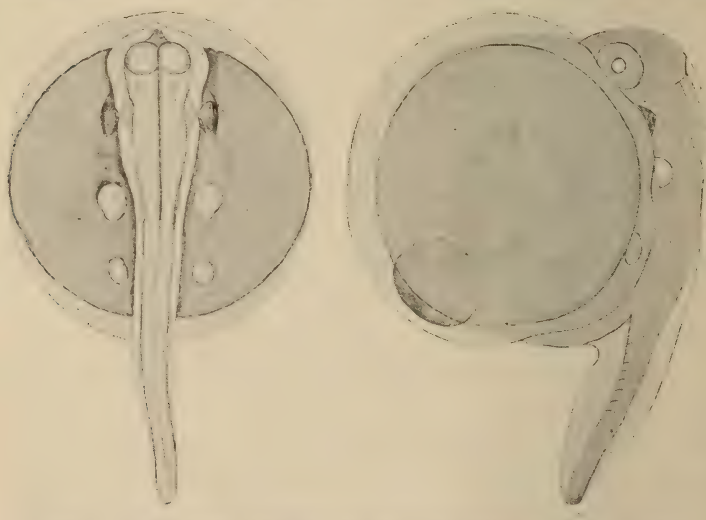


FIG. 1. Fish larva identified as that of the halibut. Mag. 13 dia.

may be thrown on the subject. The dark circular region in the yolk sac represents an oil globule. The specimens have shrunk slightly, and the largest now measures 3·9 mm. in length.

*Fish Lab. Report for 1898.

Notes on Some of the Rarer Forms from the Tow-nettings.

(1) *Acanthometra*, one of the radiolarians, has been noticed on three occasions during the year. On February 4th and 10th it was fairly plentiful in the Port Erin tow-nettings. It was also noted in a surface collection taken off Rhyl on March 27th. We have observed this organism in tow-nettings taken by the steamer in previous years, and Mr. Chadwick has also met with it at Port Erin.

(2) *Noctiluca*, so far as the tow-nettings show, appears to have extended from Blackpool to Red Wharf Bay, from the middle of July to the middle of October. It is not noted for Sections VI. and VII., or the three off-shore stations. Its absence from these, however, cannot be definitely proved, owing to the absence of sufficient tow-nettings.

(3) *Microniscus*. A number of specimens of this parasite were attached to the *Calanus* taken in the tow-netting collected at Port Erin on September 10th.

(4) *Squilla*. About thirty specimens of the late free-swimming stage were found in a tow-netting from Section VII., taken August 2nd. It does not appear to have been previously noted from any part of the Irish Sea. According to E. W. L. Holt, they are got regularly at certain seasons on the West Coast of Ireland. Professor Jeffrey Bell, in the Journal of the Marine Biological Association, N.S., Vol. VI., No. 3, records the occurrence of a single specimen of adult *Squilla desmaresti* in the North Sea in 1901, and states, on the authority of Dr. Hoek, that the only previous record for that region is an *Erichtheus* stage discovered in 1872. Two figures of one of the Welsh specimens are given with this report (Text-fig. 2).

(5) *Jaxea nocturna.* A number of specimens of the *Trachelifer* stage were taken in Section VI. on July 14th, and one specimen on July 28th. The only previous record for the Irish Sea is two specimens from a tow-netting taken in the Barrow Channel, off Piel.* It has been taken in the Clyde, and in abundance, after dark, in the Sound of Mull.†

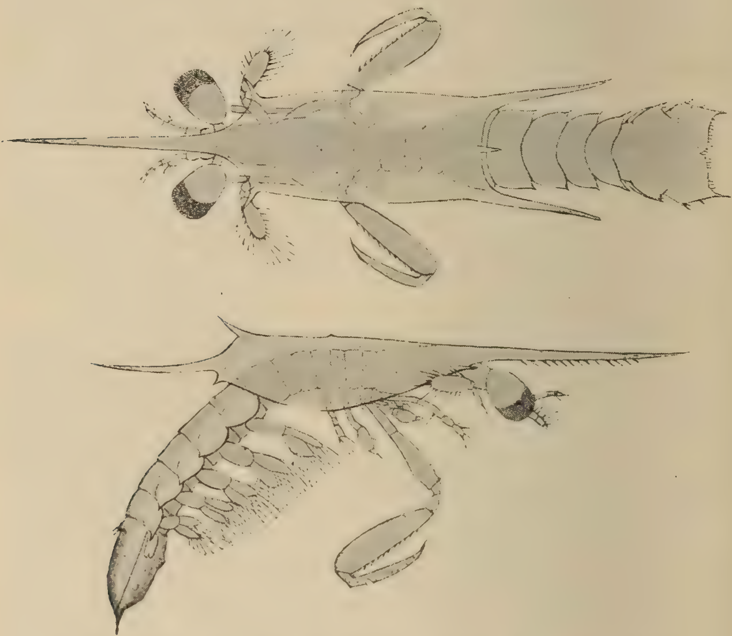


Fig. 2. Erichtheus larva of *Squilla*. Dorsal and lateral views.

(6) *Podon leuckarti* (G. O. Sars). This Cladoceran was noted on several occasions in the tow-nettings along with *P. intermedium.*

(7) *Young Mussels.* A large number of young

*Fifteenth Annual Report of the Liverpool Biology Committee, p. 13.

†Twentieth Annual Report of the Fishery Board for Scotland, Part III., p. 481.

Mytilus, ·3 to ·42 millimetre in length and ·26 to ·36 millimetre broad, were noted in the bottom tow-netting from Section I. on June 10th. They were also found at the surface and bottom on July 12th. Many of these were probably just at the point of "striking." A few that had apparently "struck," and afterwards became detached from their anchorage, showed a considerable increase of shell, the more recent portion being distinctly defined from the older by its greater transparency. These young mussels were also noted at the surface in Section II. on July 18th, and in Section VI., at the surface, on July 28th.

(8) *Young fishes.* No newly-hatched fishes were met with. Post-larval stages were scarce. The young forms noted had probably come to the surface to feed. One post-larval *Cottus* was taken at the surface in Section II. on June 9th. One post-larval Gadoid in Section VI. on May 10th. One young yellow gurnard, taken at the surface in Section V., September 3rd; one 10 millimetres long in Section VII. on August 2nd; one 9·5 millimetres long at Port Erin on June 4th. One young garfish (*Belone*), 20 millimetres long, with upper jaw undeveloped, in Section VI. on July 14th. Eight "Mackerel midges," 10 millimetres long, in Section VII. on June 26th. These were made out to be young rockling, *Onus tricirratus*. One Gadoid, 32 millimetres long, in Section VII. on July 15th. Two young weevers (*Trachinus*) in Section VII. on August 2nd. Twelve young Gadoids, 7·5 to 10 millimetres long, at Port Erin on June 4th—their stomachs were filled with Copepods.

TRAWLING OBSERVATIONS AND RESULTS.

By Jas. Johnstone, B.Sc.

1.—Trawling Observations in Luce Bay.

By the kind permission of the Fishery Board for Scotland the "John Fell" was enabled to trawl for three days during October and November, 1904, in Luce Bay. The primary object of these fishing operations was to procure a stock of mature plaice for the Piel Hatchery for breeding purposes, and for the demonstrations given in the fishermen's classes to be held at Piel in the spring of 1905. Advantage was, however, taken of the facilities thus afforded to continue the observations previously made on the distribution of the plaice within the waters of Luce Bay.

Luce Bay was at one time a very lucrative trawling ground, but in 1889 the Herring Fishery (Scotland) Act gave the Board powers to prohibit trawling within Scottish territorial waters, and also in a number of scheduled areas of which the Bay was one. A bye-law was, therefore, made which closed all the area within a line drawn from a point near Port William on the eastern side of the Bay to another point near Drummore on the West. The whole Bay is not, therefore, closed, but the valuable plaice grounds lie in-shore from this line and the Bay has been since 1890, for all practical purposes, a *mare clausum*. It is only very occasionally that trawl fishing is legally carried on there.

Certain physical and biological conditions, which we only imperfectly understand, render Luce Bay a favourite ground for plaice. It has now been closed for about 14 years, while the inshore waters of the Lancashire and Western Sea Fisheries District, where plaice are relatively abundant, are open to trawling sailing vessels, under certain restrictions. A comparison between these two areas is, therefore, of some interest.

The first visit to Luce Bay was made on October 18th and 19th. We left Fleetwood on the evening of the 17th and arrived in the Bay early in the morning of the 18th. During the passage from Piel Gas Buoy to Point of Ayre, and from the latter point to Mull of Galloway, a number of "drift bottles," which had previously been prepared, were liberated at intervals of about a mile by Mr. Scott. The object of these experiments was to obtain further information with regard to the surface drift of the sea-water in the northern part of the Irish Sea. A number were also set free in the centre of the Bay. 25 per cent. of the cards have already been returned, and it is interesting to note that none of these had gone outside of Luce Bay.

Trawling was commenced about 7 a.m. on the morning of the 18th. At the suggestion of Captain Wignall one haul was made with a shrimp net of ½-inch mesh in the shallow water in the northern part of the Bay. The object of this haul was to determine whether, as the Captain considered was likely to be the case, small plaice were abundant in this area. The net was hauled for about an hour and a quarter and the results of the drag are given in the following table:—

HAUL 1.

Fish caught.	Numbers.	Sizes.
Plaice	2	Over 14″
,, ...	157	Under 14″*
Dabs	19	2″—8¾″
Brill	1	4″
Herring	95	4½″—5″
Codling	32	3½″—4½″
Whiting	97	4½″—5½″
Poor Cod	1	3½″
Saithe—*Gadus virens*	8	5″
Pollack—*G. pollachius*......	4	5½″
Sand-eels	10	9″—10″
Callionymus lyra	1	4½″
Gasterosteus spinachia	Numerous.	5″
Acanthias vulgaris...........	1	15″
Gobius minutus	Very numerous.	2¾″
Syngnathus acus	1	8″
Siphonostoma typhle	6	10½″

* Six of these were from 9″ to 10″; the rest were about 4″.

Six hauls with a fish trawl of 30 feet beam and with 7 inch meshes throughout were then made. We endeavoured to obtain large plaice only, and in good condition, so that a large-meshed net was purposely used so as to capture as few small fish as possible and prevent injury to the mature plaice caught by invertebrate and other débris. Short drags of an hour to an hour and a quarter duration were made, and the net was hauled and cleared as rapidly as possible and then shot again. Fishing under such conditions is rather laborious work, and we

may state that Captain Wignall and the crew of the "John Fell" most cheerfully and willingly did all that was possible to render the result of the fishing thoroughly successful. We have found in the past that only female plaice of 15 inches and over in length can be depended on to yield ripe spawn. But the sizes of the males at first maturity are rather less than this, and in order to secure a sufficient number of these fishes all plaice of 14 inches and over were retained. About a hundred smaller fish (8 to 12 inches in length) were kept alive for the marking experiments also made on this occasion, but all the other small fish of 8 to 9 inches were returned alive to the sea. During the latter hauls a considerable number of medium-sized plaice were also thrown overboard alive into the sea.

The positions of the hauls on these two days are given in the sketch chart on next page. This is traced from an Admiralty chart marked by Captain Wignall.

The large plaice were at once taken from the contents of the net and put into a shallow wooden tank, and when the deck was cleared, and the net shot again, these fishes were taken out one by one, measured, and distributed among the other tanks. Sea water was continuously pumped into a large, tall wooden tub, from which it passed into the other tanks by rubber hosepipe connections. Flat low wooden tanks are best adapted for carrying live fish, but when the sea is rough, and there is much motion of the vessel, the water in these low tanks becomes violently agitated, to the great detriment of the fish. On the whole, then, large, galvanised iron, round vessels, with a contracted opening, kept full of water, are safest for the transit of the fish. No difficulty was experienced in keeping the plaice alive and in good condition, provided a constant water circulation was

maintained. On arriving at Piel the fish were put into rather small wooden tanks, and rowed ashore, and were then placed in large, flat fish baskets and carried up to the tanks in the hatchery. Of 135 large plaice put into the tanks on the steamer direct from the net only 3 died before being landed at Piel, and these had, most probably, been injured while the trawl was being hauled on board.

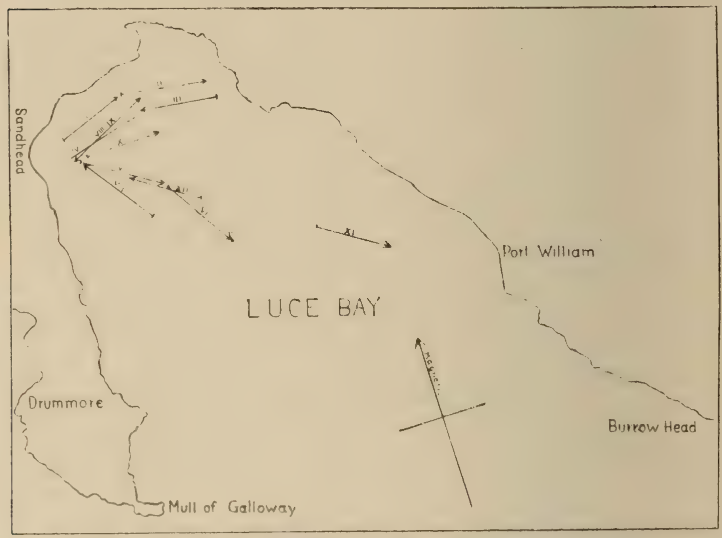


FIG. 3. Chart of Luce Bay, showing the positions and lengths of the hauls.

Physical Observations.

The usual physical observations were made during the two days, and may be summarized as follows:—

Wind—Calm at first, light southerly airs later.
Weather—Unsettled at first, dull afterwards;
Sea—Smooth;
Barometer—30·7 to 31 inches;

Air temperature—Dry bulb: 54° F. to 53° F.;

Wet bulb: 53°·5 F. to 57° F. (the air was saturated during part of the 18th);

Sea temperature at surface—10°·6 C. to 12°·2 C.;

Specific gravity of sea at surface—1026 to 1026·3;

Transparency of sea—The greatest depth at which a white enamelled 2ft. disc could be observed was 15ft.

The fishes caught in 11 hauls made on the two days are tabulated on the following pages.

Invertebrates taken in the Net.

Special attention was not directed to the invertebrates caught, but the following forms were identified:—*Cyanea* (a few), *Alcyonium digitatum*, *Cucumaria planci* (very numerous in almost every haul, this was by far the most abundant invertebrate), *Ophioglypha*, *Ophiura*, *Asterias*, *Cribrella*, *Astropecten*, *Solaster*, *Echinus* (numerous), *Portunus holsatus*, *P. puber*, and *P. corrugatus*, *Macropodia longirostris*, *Hyas araneus*, *Carcinus maenas*, *Cancer pagurus*, about a dozen lobsters altogether (most from 6 to 9 inches in length), Hermit Crabs (very abundant), *Crangon*, *Pandalus* (only one or two specimens), *Porcellana longicornis*, *Hippolyte varians* (a few specimens on seaweeds), *Buccinum*, *Fusus* (both numerous), *Cyprina*, *Ostrea*, *Mytilus modiolus*, *Pecten opercularis* (numerous in several hauls), *Rissoa parva*, *Aphrodite* and several other Polychaetes, "knarrs" containing *Sabellaria*, simple Ascidians (numerous).

The plankton obtained is described elsewhere by Mr. Scott.

Six Hauls with a Fish Trawl in Luce Bay on October 18th, 1904.

Fish Caught.	Haul 2.	Haul 3.	Haul 4.	Haul 5.	Haul 6.	Haul 7.
Plaice over 14"	17	16	17	18	6	27
,, under 14"	20	356	138	242	78	409
Dabs	70	145	45	67	44	99
Sole	...	...	...	1	...	...
Turbot	...	...	...	...	...	1
Brill	...	...	...	...	...	2
Skate (*Raia batis*)	2	1	1	45	...	68
Ray (*R. clavata* and *maculata* chiefly)	20	15	24	...	116	...
Total edible Fishes	129	533	225	373	244	606

FIVE HAULS WITH A FISH TRAWL IN LUCE BAY ON OCTOBER 19TH, 1904.

Fish Caught.	Haul 8.	Haul 9.	Haul 10.	Haul 11.	Haul 12.
Plaice over 14″	7	12	2	4	7
,, under 14″	74	81	35	77	53
Dabs	25	21	3	24	18
Brill	...	...	2	...	...
Solenette	..	...	...	1	...
Ray	8	6	20	24	5
Total edible Fishes	114	120	62	130	83

Fish Parasites.—The following forms were identified; they are described in detail elsewhere in this Report:—Trematodes: *Distomum valdeinflatum*, Stossich (from the dab); *Gasterostomum* sp. (from the plaice); *Udonella caligorum* on *Caligus* (from the cod). Cestodes: *Bothriocephalus punctatus*, Miller (from the turbot and brill). Protozoan: *Lymphocystis johnstonei*, Woodcock (from the flounder). Several flounders, abnormally scaled, were also taken, and are figured elsewhere.

Sizes of the Fish Caught.

The tables give, for the most part, only the sizes of the smallest and largest fishes caught in each haul. But in all the hauls plaice of over 14 inches long are distinguished from those of under 14 inches, and in one haul all the plaice of under 14 inches were individually measured so as to get an average size. This was also done with the plaice of over 14 inches in length. The results may be summarized as follows:—

(1) Plaice **over** 14 inches in length formed **8**% of all plaice caught;
(2) Plaice **under** 14 inches were **92**% of all caught;
(3) The average length of the plaice **over** 14 inches was **16** inches;
(4) The average length of the plaice **under** 14 inches was **9·8** inches;
(5) The average length of **all** the plaice caught was about **10¼** inches.

Among the other flat fishes caught were some that struck us as unusually large (for fish in in-shore waters). Several dabs were obtained measuring from 13½ to 14 inches and weighing from 1lb. 1 oz. to 1lb. 3½ oz. On the 18th November, when a further visit to the Bay was made,

some flounders were obtained, which measured from 13½ to 16½ inches. A turbot 24 inches long was also caught on the 18th October. Captain Wignall and the crew of the steamer, who have a thorough acquaintance with the kind of fish caught in in-shore waters in the Lancashire and Western Fisheries District, all remarked on the unusually large size of the dabs and flounders.

Comparison with Previous Years' Fishing.

In all cases when fishing in Luce Bay we have used uniform fishing gear (the trawl beam 30 feet long, and the meshes of the net 7 inches throughout), and drags of about one hour to an hour and a quarter have nearly always been made. The results of each year's fishing can, therefore, be compared with each other. They are:—

Year.	Average catches of Plaice.	Average catches of all food Fishes.
1902	179	132
1903	272	197
1904	238	154

On the Tow-nettings Collected in Luce Bay.

Surface collections were taken by tow-net during every drag with the fish trawl on both visits to this Bay. The result of the examination is given below. The difference in the general constituents of the surface life is very slight. One or two of the organisms present in October had apparently disappeared before the next visit in November. On the other hand some forms found in November were not noted in October.

Diatoms. The collections gave three species, *Coscinodiscus*, *Biddulphia* and *Chœtoceros.* The latter was only found in October. The two former species were extremely abundant on the first visit, but less numerous on the second, and *Coscinodiscus* was then the prevailing form.

Protozoa. *Ceratium tripos*, *C. fusus* and *C. furca* were represented by a small number of specimens in October.

Cœlenterata. Many small *Pleurobrachia* were taken during the two visits.

Vermes were represented by *Sagitta*, *Tomopteris* and *Autolytus.* The former was plentiful in October, but less numerous in November. The other two were present during both visits, one or two being taken in every townetting.

Copepoda. The Copepoda noted, were *Calanus*, *Pseudocalanus*, *Paracalanus*, *Temora*, *Acartia*, *Oithona*, *Labidocera*, *Anomalocera*, and *Monstrilla*. *Pseudocalanus*, *Paracalanus* and *Monstrilla* were found in November, *Labidocera* and *Anomalocera* in October. The whole of the collections contained a large number of Copepoda, but with the exception of *Acartia* the species given above were only represented by one or two specimens. The Copepoda practically consisted of *Acartia discaudata.* A few *A. clausia* were present amongst them. One female and several males of a *Monstrilla* taken in November appear to be distinct from any of the described species. The female resembles *M. gracilicauda* in general features, but differs in the structure of the fifth feet. These are long and narrow and have only two setæ on each branch. The branches are ciliated along the inner margin near the apical end. The males are easily recognised by the serrate appearance on the upper margin of the last joint of the antennules. The species will be described more fully in a later report should it turn out to be a new species.

Cladocera. *Podon intermedium* was present during both visits, and *Evadne* in October.

Larval Crustacea were only present in the November gatherings, and consisted of Copepod nauplii (very abundant), Cyclops stage of *Lernœa* few, larval *Crangon* few, *Porcellana* zoea rare, zoea of other species of crabs frequent.

Ascidians. *Oikopleura* occurred in all the collections.

Two specimens of a young Clupeoid fish 23 millimetres long were taken in November.

A. Scott.

General Remarks.

In considering the results of the trawling operations in Luce Bay for the last three years, one cannot help making comparisons between the condition of this ground and that of our own in-shore waters on the West Coast of England and that of Wales. Our primary object in going to Luce Bay has been to secure mature plaice for hatching purposes, for general experience of our own in-shore grounds has shown that it is only by an unreasonable expenditure of time there that a stock equal to that which may be caught even in a single day's trawling in Luce Bay can be obtained. Four years ago the "John Fell" spent the greater part of a week in endeavouring to obtain mature plaice for Piel on the grounds in the Southern part of our district, and was most unsuccessful, only five obviously mature fish being obtained. Even such an admitted "plaice ground" as Red Wharf Bay, off the North Coast of Anglesey, yields poor results. This latter area may be compared with Luce Bay. It is true that it has quite a different exposure, but it is the nature of the bottom, physically and biologically, which, no doubt, is the principal factor in rendering each area a favourite

habitat for large plaice. We made three hauls in Red Wharf Bay during November of this year, with the object of obtaining small plaice for the marking experiments, and some attention was directed to the size of the plaice captured. The statistics taken on this latter area are not comparable with those quoted for Luce Bay, as a net of smaller mesh was employed in Red Wharf Bay, in order to get a good catch of fish of from 8 to 11 inches in length for the marking experiments. But it is no exaggeration to say that in these three hauls not over ten plaice of over 15 inches in length were obtained, while the largest fish caught was 16 inches long, and in two out of the three hauls not one plaice of that size was obtained. It is admitted generally that the principal effect of much trawling on a ground is to diminish the average size of the fishes inhabiting it. Now trawling is permitted to be practised by sailing vessels, subject to the employment of a mesh not less than 7 inches in periphery, in Red Wharf Bay, while this method of fishing is prohibited unconditionally in Luce Bay, and it is this difference which, in all probability, accounts for the fact that large plaice are present in tolerable abundance in the latter area, while they are very scarce in the former one. If trawling in any form were prohibited effectively in Red Wharf Bay—a prohibition which, however, we are very far from advocating—there can be little doubt that in the course of a dozen years large plaice would be abundant there also.

The result of the single haul with a shrimp trawl, which was made in Luce Bay on October 18th, goes very far towards destroying the sharp distinction made hitherto between "nursery grounds" and mature fish grounds. Many hauls made on the Burbo Banks nursery grounds, for instance, present a considerable resemblance

to that made in Luce Bay on the date referred to. The average haul made in the former area (Burbo Bank shrimping ground), in October, 1893-1899, was as follows* :—

Soles	41
Plaice	230
Dabs	520
Whiting	512

There are, of course, marked differences in the catches made in the two areas. Thus, small soles, which are fairly represented in the Mersey ground, were not taken in Luce Bay, and small dabs were not relatively abundant in the latter area. The great variety of small gadoid fishes seen in Luce Bay, again, is seldom, if ever, found in catches made off the Mersey. But these differences are those which one might naturally expect to find in the fish faunas of different grounds, and do not militate against the idea that Luce Bay, as displayed in the result of the catch referred to, is a small fish nursery. We spent some time during September fishing for small plaice in Liverpool Bay, for the transplantation experiments of the Scottish Fishery Board, and in the majority of the hauls made at that time more than 150 plaice (the number taken in one haul in Luce Bay in October) were seldom taken.

But in this one haul in Luce Bay, not only was the catch which we regard as characteristic of a nursery ground made, but two large mature plaice (15-16 inches) were also obtained, and it was, doubtless, due to the fishing action of the shrimp trawl that more were not taken. Taking into account the catches made with both fish and shrimp trawls, it is evident that plaice of all

* See Lancashire Sea Fisheries Laboratory Report for 1900, Table III.

sizes, from $2\frac{1}{2}$ to 22 inches, are present on the same ground. Large plaice are present on the Luce Bay area because they are not caught, and, conversely, they may be absent from the Lancashire nurseries because they are fished out, and not because the latter areas are naturally small fish grounds. It is, of course, quite proper to use the term nursery in relation to the latter areas, but it is, most probably, the artificial conditions resulting from commercial trawl fishing that have called into existence the apparent segregation of small immature fishes on these in-shore grounds.

The results of hauls 1 and 2, on 19th October, are incidentally of interest in connection with the question of how far a haul with a trawl net is to be regarded as affording a fair sample of the fishes present on the area swept by the trawl net. At the suggestion of Captain Wignall, these hauls were made over the same strip of ground (as determined by shore marks). but in opposite directions. The catches are given below in parallel columns:—

Fish caught.	Haul 1.	Haul 2.
Plaice over 14″ long.........	7	12
Plaice under 14″ long	74	81
Dabs	25	21
Raia clavata	8	6
Total food Fishes caught...	114	120

The similarity of results between the two catches is very striking, especially when it is remembered that it is very difficult to trawl over exactly the same strip of sea bottom, and, further, when the marked differences which

the exact locality makes is borne in mind—differences which are especially well indicated in the results of the hauls made in Luce Bay.

2. Six Hauls with a Fish Trawl in Luce Bay, on November 18th, 1904.

By permission of the Fishery Board, the third day's trawling was deferred to November 18th. On this occasion, all plaice of 13 inches and over in length were brought back alive for hatching purposes. By making use of this limit of size an average of from 15·5 inches to 15 inches (according to the haul) was obtained. On the whole, plaice were scarcer and smaller on this date than was previously the case. With this exception, the results are fairly similar to those recorded above, and need not be separately discussed.

A table of the results of the hauls follows:—

Six Hauls with a Fish Trawl in Luce Bay, on November 18th, 1904.

Fish caught.	Haul 1.	Haul 2.	Haul 3.	Haul 4.	Haul 5.	Haul 6.
Plaice over 13″ long......	25	22	9	9	8	34
Plaice under 13″ long ...	48	55	51	210	67	70
Dabs	40	23	17	66	21	...
Lemon Soles	3	...	...	...	...	...
Flounders	...	4	1	...	...	...
Skate	2	...	2	3	...	3
Ray	32	4	9	5	5	44
Cod	...	...	...	1	...	1
Total food Fishes...	150	108	89	294	101	152

3. Distribution of Plaice and Dabs.

Some notes on this subject, derivable from the trawling statistics collected by the officers of the Committee, may be of interest. I will take, first of all, all the observations made on the distribution of immature fishes on the Blackpool closed ground:—

Date.	Dabs caught.	Plaice caught.	
July 14, 1903	740	42	These hauls were made by Captain Wignall, using a shrimp trawl from the steamer.
Aug. 2, ,, ...	1,350	52	
Dec. 11, ,, ...	18,050	20	
*Feb. 12, 1904	2,685	3	
April 14, ,, ...	3,429	12	
May 4, ,, ...	390	4	
,, 31, ,, ...	514	62	
June 10, ,, ...	78	41	
,, 10, ,, ...	534	31	
,, 31, ,, ...	200	92	
July 14, 1903	72	...	These hauls were made by Mr. J. Wright, using two shank nets from the sailing cutter "Piel Castle."
†Sept. 16, ,, ...	30	5	
Nov. 13, ,, ...	1,479	7	
Dec. 29, ,, ...	2,081	...	
Jan. 12, 1904	1,270	7	
Feb. 5, ,, ...	15,513	7	
March 15, ,, ...	3,893	...	
,, 24, ,, ...	10,300	17	
May 10, ,, ...	390	47	
,, 30, ,, ...	50	...	
June 27, ,, ...	73	9	

* A shrimp shank net was used on this occasion.
† Only one shank net was used on this occasion.

It will be seen from these figures that young plaice are *very* scarce on the Blackpool closed ground, and that dabs are relatively very abundant. Further, dabs are extremely abundant during the cold winter months.

Thus, on December 11th, Captain Wignall made what is almost a record haul of these fishes, viz.,18,050 in one drag of an hour's duration.

It is interesting to compare with the above results those obtained by Mr. Eccles on the Mersey shrimping grounds. I give the average hauls for each month of the same year. Usually two or three hauls were made each month.

Month.	Dabs caught.	Plaice caught.	
July, 1903	666	51	These hauls were made using a shrimp trawl from the sailing cutter "Rock-light."
August, „	1,159	21	
September, „	699	72	
October, „	233	5	
November, „	305	10	
*December, „	711	274	
January, 1904	31	23	
March, „	195	10	
April, „	90	7	
May, „	35	4	
June, „	23	19	

* Plaice were unusually abundant this month.

The above figures show that on the Mersey shrimping grounds immature plaice are, on the whole, about as abundant throughout most of the year as on the Blackpool ground, and, also, that they are more abundant on the former ground in the middle of the winter. But the figures also show that there is not, by any means, the same disproportion between plaice and dabs. That is, dabs are very much more numerous *in proportion to plaice* on the Blackpool than on the Mersey grounds.

In the Fisheries Laboratory Report for 1902, I gave a summary of the statistics of immature fishes caught in the shrimp trawling observations during the years 1893-

1902. It will be convenient to quote those figures here for comparison with the records just given. They are:—

AVERAGE CATCHES OF PLAICE AND DABS.

Period.	Blackpool Closed Ground.		Mersey Shrimping Ground.	
	Dabs.	Plaice.	Dabs.	Plaice.
3rd quarter, 1893-7...	1932	1268	706	901
3rd quarter, 1898-1902	1316	231	549	157
3rd quarter, 1903......	...	...	802	52
3rd quarter, 1904......	...	...	794	169

All the hauls on the Blackpool closed grounds were made by Captain Wignall, and all those quoted for the Mersey grounds by Mr. Eccles. They are all hauls with a shrimp trawl. We have not enough hauls with a shrimp trawl on the Blackpool ground to make reliable comparisons for the years 1903-4, and it would not do to use Mr. Wright's hauls for this purpose, as the fishing action of a shank net is different, with regard to small fishes, from that of a shrimp trawl. But the figures show that plaice have become very much scarcer than dabs on the Blackpool area, and a glance at the table of hauls made by Captain Wignall on that ground during the year June, 1903—June, 1904, will show that this poverty of plaice as compared with dabs still continues. The same change has taken place on the Mersey area, but to a much less marked extent. Plaice there are scarcer than they used to be, but the disproportion between them and dabs is not nearly so great as on the Blackpool ground.

When the Scottish Fishery Board closed the terri-

torial waters of the Firth of Forth and St. Andrew's Bay, they took very full statistics of the fish caught on these areas. These statistics extended over 10 years, and in the Report of the Fishery Board for 1895* they are summarized. This table is given in the Report for 1898.

	Number of hauls.	Plaice and Lemon Soles caught.	Dabs and long rough Dabs caught.
1886-1890	325	29,869	19,825
1891-1895	466	28,044	29,483

In this case trawling observations shewed that, during the 10 years in which the grounds had been closed, plaice and lemon soles had decreased, while the coarse fish, dabs and long rough dabs, had increased. Dr. Fulton attributed this to the fact that a great increase of trawling had taken place during these ten years on the grounds *outside* the closed area; and that spawning plaice and lemon soles, which frequent these off-shore areas, had decreased in consequence of this increased fishing, and that the in-shore grounds had been robbed of fry and young fishes. On the other hands, dabs and long rough dabs were not caught to the same extent, because these fishes, when mature, frequent in-shore waters to a greater extent than plaice and lemon soles, and spawn there. Further, they are smaller fishes, and so escape capture to a greater extent.

Now, this argument may apply also to our in-shore and off-shore grounds off the N.W. Coast of England, but it is also just possible that there may be another explanation. The figures I have quoted from the Committee's

* Part 3, p. 25; see also Report for 1898, pt. 3, p. 128.

statistics show, I think, that dabs have become much more numerous, with regard to plaice, on the Blackpool ground (which is closed against trawling) than on the Mersey ground (which is open to trawling). This suggests that closing the former ground has favoured the dabs much more than the plaice. In what precise way, it is difficult to conjecture.

It is always very difficult to forecast what may be the result of interference with natural conditions with regard to marine animals. Thus, according to the cockle fishermen of Morecambe Bay, cockles are not so abundant in many places as they used to be, because of their destruction by sea-birds, which have increased greatly on account of the operation of the Sea Birds Preservation Acts. Then the Inspectors of Salmon Fisheries for England and Wales pointed out* the positively injurious effects of fish culture in American fresh waters. The introduction of the fry of a fresh-water fish—the black bass (*Micropterus dolomieu*)—not only led to the practical destruction of the trout in the streams into which this fish had been introduced, but by-and-bye the bass themselves became dwarfed, and nearly valueless as game fishes.

Too much reliance can, of course, be placed on the statistics quoted above, but it is evident that the conclusion which I have suggested may be as reasonable as any that may be deduced from the facts.

4. Occasional Scarcity of Shrimps on Blackpool Closed Ground.

On June 10th, 1904, several hauls were made on the above ground, with the object of getting some shrimps for bacteriological analysis. Usually there is no difficulty

* See their Annual Reports for 1897 and 1898, pp. 14-15 and 6-9 respectively.

in getting a good catch of these animals here, but on this occasion, after a drag of one hour over about two miles of ground, no shrimps whatever were found in the catch made by the shrimp trawl net, though 173 small fishes of the usual kinds, and the usual invertebrates, were caught. Another haul was then made with the shrimp trawl a little nearer the shore, and on this trial 576 small fishes were caught, but only two shrimps. Fishermen believe that when shrimps are so scarce as this they either have migrated into deeper water, or they "dawk," that is, bury themselves in the sand. To test this latter theory, a shank net was put out, and dragged for another hour. Fewer fishes were caught, as usually happens with a shank net, but there were only three shrimps in the catch, though it was evident, from the abundance of *Mactra* and other molluscs taken, that the bar of the net frame had been digging into the surface layer of the sand on the bottom. The wind was blowing strongly from E.N.E. at the time, and had been easterly generally for the past eight days, and Captain Wignall attributed the scarcity of shrimps to this prevalence of easterly winds.

This scarcity of shrimps on Blackpool closed ground has been noticed many times before in the observations made by the "John Fell" and bailiff cutters. The following observations may be quoted here:—

Trawl	May 31, 1895,	no shrimps,	187	fishes,	wind	S., easy;
Do.	June 20, 1895,	,,	713	,,	,,	N.W., "whole sail"
Shank	Dec. 16, 1897,	,,	117	,,	,,	S.E., strong;
Do.	do.	,,	227	,,	,,	do.
Trawl	Dec. 22, 1897,	,,	1916	,,	,,	S.S.E., easy;
Do.	do.	,,	1615	,,	,,	S.S.E., fresh;
Do.	Mar. 7, 1898,	,,	1027	,,	,,	N.E., easy;
Do.	do.	,,	1233	,,	,,	do.
	(This latter haul made with an extra chain on foot rope.)					
Do.	Aug. 2, 1899,	no shrimps,	1027	,,	,,	N.N.W., easy;
Do.	July 24, 1901,	3 shrimps,	980	,,	,,	N.E.;
2 shanks...	May 30, 1904,	no shrimps,	87	,,	,,	N.E.

These are all the hauls on record in which less than three shrimps have been caught in one haul, and in most of the cases the wind has had some element of East in its direction. There are, of course, other hauls on record in which fair catches of shrimps have been made under apparently somewhat similar conditions. Too much may, indeed, be made of such observations, for fully to investigate the causes of such local scarcities of shrimps would necessitate a thorough examination of weather records for the week or fortnight preceding the date of the hauls. But the observations I have quoted show with some degree of probability that the direction of the wind does affect the abundance of shrimps in this locality—though not necessarily in others.

5. A Haul of Dogfishes.

An exceptionally large catch of these fishes was made on September 20th, 1904, on the grounds near Liverpool N.W. Lightship. On these grounds one usually expects to get a fair catch of plaice, soles, dabs, skate, ray and other edible fishes, with, perhaps, half a dozen or so dogfishes. On this occasion, however, the net came up, after about one hour's drag, apparently full of dogfishes. The latter were counted, and about 350 in all were found among the catch. The other fishes taken were 35 dabs, 27 grey gurnards, 14 soles, 9 lemon soles, 3 each red and yellow gurnards, 3 plaice and 1 skate. The net had evidently encountered a "school" of dogfishes. The latter belonged to three species—*Scyllium canicula*, *S. catulus* and *Acanthias vulgaris*. The latter was the commonest form, but the exact numbers of each species were not counted. All the dogfishes were cheerfully destroyed by the men before being thrown overboard.

6. Food of Plaice and Soles.

Very generally it is found that plaice feed almost exclusively on small bivalve molluscs, such as mussels, cockles, and such forms as *Scrobicularia*, *Tellina* or *Nucula*, while soles prefer nereid worms. But occasionally this choice of food is entirely reversed. Thus in a haul made off the Liverpool N.W. Lightship, on 27th September, 1904, all the plaice dissected (about half-dozen) were found to be feeding entirely on nereid worms, while the principal contents of the stomachs of the soles examined were the bivalves *Solen* and *Scrobicularia*, and nereids and prawns, though also present, were not apparently a favourite food. In Luce Bay, again the stomachs of most of the plaice examined contained *Nucula*, *Donax* and *Solen*, but in many cases nereids were the commonest food, and in others the stomachs contained the unusual food animals, ophiuroids and amphipods.

7. Weights of Soles and Plaice of various lengths.

Several soles caught off Morecambe Bay Lightship, on 20th September, 1904, were measured and weighed, and the results recorded. The latter may be of interest, as shewing how very rapidly the weight increases with increasing length.

Length.	Weight.
9½ inches.	3¾ ozs.
10 ,,	4½ ,,
12 ,,	8½ ,,
12½ ,,	9 ,,
13½ ,,	15 ,,
14 ,,	14½ ,,
15 ,,	18½ ,,

The law governing the increase in weight of similarly shaped bodies of increasing dimensions is that the weight increases directly as the cube of any one of the dimensions. Thus, if a fish is doubled in length its weight ought to be increased eight times. The increase in weight of fishes with even slightly-increasing length is, therefore, very great.

Several plaice caught on the Mersey shrimping grounds, and measured and weighed, gave the following results:—

Length.	Weight.
$7\frac{1}{2}$ inches.	$2\frac{3}{4}$ ozs.
8 ,,	$3\frac{1}{4}$,,
9 ,,	5 ,,
10 ,,	6 ,,
12 ,,	$9\frac{1}{2}$,,

Dr. Fulton* points out, however, that the weight of a fish always increases more rapidly than the above law indicates. This is because the growth is unequal, the fish increasing more rapidly in breadth or thickness (probably the latter) than in length.

8. Exceptionally low specific gravity of the Sea Water off Blackpool.

On November 13th, 1904, while trawling off Blackpool, an exceptionally low reading of the hydrometer was taken. The weather was fine and the sea smooth, with an easy S.E. breeze. The surface temperature was 8·6° C., and the specific gravity 1021·8 (taken with the Kiel aräometers. On reduction, to compensate for the

* An. Rept. Fishery Bd. for Scotland, 1904, pt. 3, p. 141.

low temperature, this specific gravity would be lower still. It is only on very rare occasions that specific gravities less than 1024 are observed in the open sea. Of course, very low values are sometimes obtained in estuaries. Thus, on 16th November, 1901, at low water, a specific gravity of 1017·1 was taken at Liverpool Landing Stage. In the case of the Blackpool determination, which I refer to here, the cause was the exceptionally heavy floods which had taken place in both the Ribble and the Wyre about a week previously. The fresh water poured down from these rivers was, even a week later, forming a surface layer on the adjacent sea area. What the reading 1021·8 of the hydrometer means is that the normal sea water on the surface had become mixed with (roughly speaking) about 20 per cent. of fresh water.

BACTERIOLOGICAL INVESTIGATIONS IN RELATION TO SHELLFISH POLLUTION BY SEWAGE MATTER.

By Jas. Johnstone.

I. METHODS.
II. THE MUSSEL BEDS IN THE MERSEY ESTUARY.
III. MUSSEL BEDS IN THE LUNE ESTUARY.
IV. DEEP-SEA OYSTERS.

I. Methods.

It is advisable to give some account of the methods employed in the analyses of the shellfish dealt with, since doubt is often felt as to the identification of bacterial species when statements of the methods employed are not made. In the following investigations the method in use in the Thompson-Yates laboratories at the University of Liverpool, for the isolation and identification of organisms belonging to the colon and typhoid groups, has been employed. This method was elaborated by Dr. A. McConkey,* and subsequently by Dr. A. Grunbaum,† and depends on the inhibitory action of taurocholate of soda prepared from ox-bile, on incubation at the relatively high temperature of 42° C., and on the further identification of the microbes thus isolated by their reactions with various sugar and glycerine media. It is somewhat laborious but it insists on a more stringent proof of the identity of *Bacillus coli*, and other organisms derived from the human intestine, than the other methods commonly followed in the past.

Batches of six to twelve mussels (or oysters) have

* Reports. Thompson-Yates Laboratories, Liverpool, Vol. 4, pt. 1.

† British Medical Journal, June 14, 1902.

been examined, and each shellfish is analysed separately. The shellfish have always been gathered from different parts of the bed so that a sample representative of the whole area is obtained. When collected by myself (or Mr. Scott) the shellfish are put at once into sterilized tins with tight-fitting lids and brought to the laboratory in these vessels. Whenever practicable the analysis has been begun on the day of collection so as to avoid changes in the food contents of the fish. When this was not practicable the tins were put into large basins and kept surrounded with ice during the period pending examination.

The exterior of the shells is scrubbed under the tap (Liverpool tap water is free from *Bacillus coli*) with a hard brush and the fish are laid down on a sterile towel. They are then opened one at a time with sterile knives, and a cut is made through the visceral mass over the region of the stomach so that the cavity of the latter is opened. Sterile pipettes have previously been made by drawing out pieces of glass tube, and one of these is used for each animal examined. A small quantity (0·1 to 0·25 cc.) is then taken from the liquid which fills up the incision in the body of the fish, and this is used for the primary inoculation. This liquid is principally the food contents of the stomach, but it also contains blood, and the liquid which fills up the acini of the digestive gland or "liver." This latter gland is very probably to be regarded as an extension of the cavity of the stomach in which digestion takes place, so that it also contains food contents. The analysis is, therefore, that of the substances, partly changed by digestion, on which the molluscs have been feeding at the time of capture.

One pipetteful of this liquid is then placed on the surface of "neutral-red, bile-salt, lactose agar," pre-

viously poured into a Petri dish and allowed to set, and is then spread evenly over the surface of this medium by means of a sterile, wide loop of platinum wire. The Petri dish is then inverted and put into the incubator. At the same time a similar pipetteful of the liquid is inoculated into a tube of sterile litmus milk, which has previously been heated to 100° C. for half an hour, and then cooled rapidly. The tubes of milk thus inoculated are then heated to 75°-80° C. for twenty minutes, and are packed into an ordinary litre gas-jar (which holds about a dozen 5in. test-tubes). Pyrogallic acid has previously been placed in the bottom of the jar and strong caustic soda solution is then poured in so as to dissolve the acid. The jar is then tightly stoppered by a rubber bung and put into the incubator. At first I used a modification of Bulloch's anærobic culture apparatus and displaced the air in the jar by hydrogen, but this treatment is unnecessary, for anærobic conditions are secured by the method indicated above.

The cultivation of the stomach liquid on the neutral-red agar medium enables one to isolate colonies of *B. coli*. The anærobic cultivation in milk isolates and grows the spores of a bacillus—in most cases *B. enteritidis sporogenes*.

These cultures are incubated for 24 hours at 41°·5-42° C. With some little experience one is then able to pick out the colonies on the neutral-red agar plates, which are probably those of *B. coli*. From each plate two or more colonies, representative of those judged to be produced by this microbe, are then sub-cultured on the surface of sloping nutrient agar in tubes. These secondary cultures are then incubated for 24 hours at 42° C. Also at the end of 24 hours the milk tubes are examined and the presence or absence of the well-known "enteritidis reaction" recorded.

From each secondary agar culture a tertiary sub-culture is made in a tube of each of the following media. Bile-salt glucose broth (McConkey's well-known medium), litmus glucose, lactose, mannose, sucrose, and glycerine broths, and litmus milk. These tertiary sub-cultures are then incubated for 48 hours at 42° C. and the results, production of acid and gas, and in the case of the milk, acid and clotting, noted. The secondary agar cultures are also examined for the motility of the microbes.

By *Bacillus coli* is understood a microbe giving the following reactions:—

1. Deep red colonies (surrounded by a haze usually if deep) in neutral-red, bile-salt, lactose agar.
2. Acid and gas in bile-salt glucose broth.
3. ,, ,, glucose broth.
4. ,, ,, lactose broth.
5. ,, ,, mannose broth.
6. ,, ,, or no change in sucrose broth.
7. No change, or simple acid in glycerine broth in 48 hours.
8. Acid and clotting in milk.
9. Well-marked motility in young agar cultures.

It will be seen then that the process of analysis is laborious and cannot be hurried.

In the case of the examination of a dozen mussels 24 primary cultures have to be made. When the neutral red primary plates are examined the colonies resembling those produced by *B. coli* are counted and recorded as "colon-like colonies." From the twelve plates so counted perhaps 18 (at the least) separate colonies are sub-cultured on agar and each of these is then sub-cultured 7 times—that is 126 tertiary sub-cultures may be made. Of the 18 colonies thus examined in detail, perhaps 9 will prove

to be *B. coli.* We are then justified in concluding that half of the colonies recorded as "colon-like colonies" are those of *B. coli.*

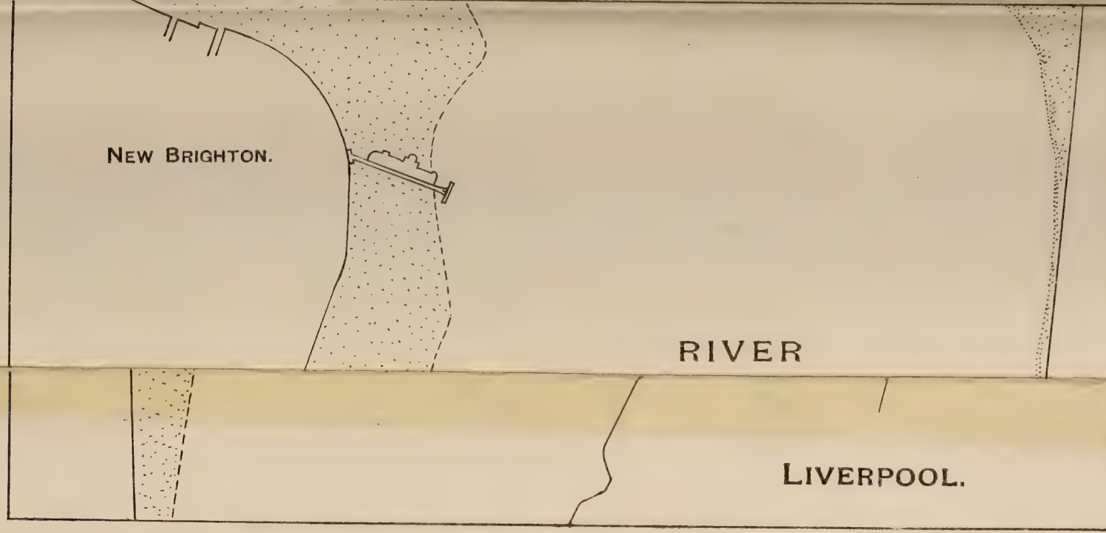
II. The Mussel Beds in the Mersey Estuary.

The Egremont Mussel Bed.

The dangerous pollution of this mussel bed was first noticed by Dr. Craigmile, Medical Officer to the Wallasey Urban District Council. Some years ago this gentleman made a report to his Council and drew attention to a case where two persons—a father and son—both developed enteric fever in a very severe form in consequence of eating mussels (or cockles) from the bed near the Egremont Ferry slip, and one of them died.* The Health Committee then took action, and posted notices along the river wall, from Seacombe to the Shore Road on the Wallasey sandhills, warning the public of the danger incurred by gathering and eating mussels from this foreshore, and forbidding this practice. Further than this, however, the Committee could not go, as the law gave them no power to prosecute. The practice of gathering mussels, for sale as food, from the Wallasey bed, continued then. About the beginning of 1903 the late Mr. R. A. Dawson took the matter up, and generally the whole question of the pollution by sewage of the shellfish beds in the Lancashire and Western Fisheries District, and both he and Professor Herdman gave evidence† on this subject before the Royal Commission on Sewage Disposal, which was then considering the question of the pollution of shellfish beds by sewage and trade effluents.

* See Dr. Craigmile's letter to the late Mr. Dawson; printed in 4th Rept. Roy. Comm. Sewage Disposal, Vol. II., p. 3; [cd. 1884] 1904.

† 4th Rept. Roy. Comm. Sewage Disposal, Vol. II., pp. 1 and 90; [cd. 1884] 1904.



THE EGREMONT MUSSEL BED AND THE NEIGHBOURING SEWERS.

portion of the Bed occupied by young mussels;

old mussels;

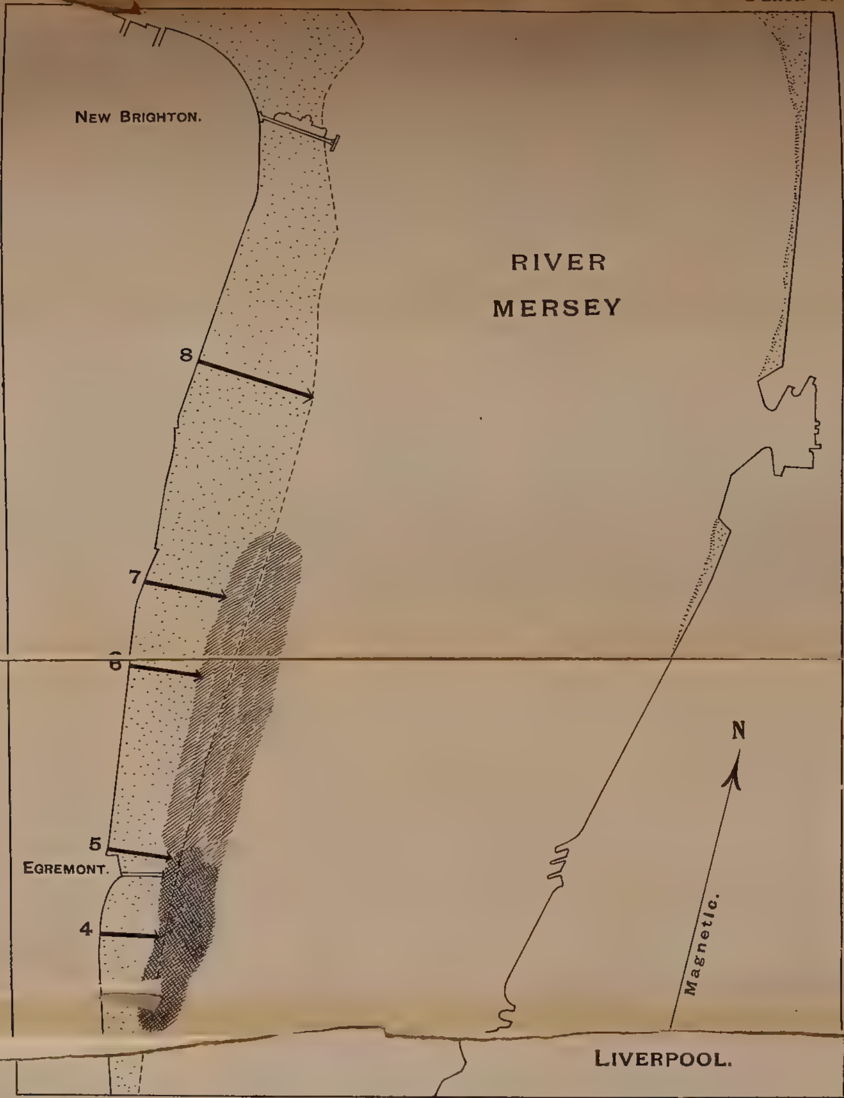
the sewage outfalls.

Subsequently Mr. Dawson and Professor Herdman prepared reports on the matter, which are reprinted in the Report for 1903 of the Lancashire Sea Fisheries Laboratory.‡ Then about the beginning of the present year I was instructed by the Committee to make a bacteriological analysis of the mussels growing on this, and the other beds, in the Mersey Estuary.

Two preliminary analyses of the mussels from Egremont were made on January 4th and 18th, 1904. Then a third and more detailed examination was made on February 3rd. On February 2nd I visited the bed at low water with Mr. Fish, one of the bailiffs at New Brighton. The exact situation of the bed, and the sewer outfalls in proximity to it, are shown in the accompanying sketch chart, Plate I., which is reproduced from a chart of the shellfish beds of the whole district, prepared by the late Mr. Dawson, and submitted by him in evidence before the Sewage Commission.* At that time the bed consisted of two portions, one to the North of the Ferry-slip, which contained only young mussels, and was not fished, and the other, South of the slip, on which large mussels were present. It was from this southern portion that I collected the sample for analysis. While we were on the bed two men came down with bags and began to gather the mussels, but were persuaded by Mr. Fish to go away. But just as we left, several men came on the bed with a cart and began to take the mussels. The bed, then, was being worked at that time. Just now (December, 1904) Mr. Eccles informs me that there are practically no large mussels left on the southern portion,

‡ 4th Rept. Roy. Comm. Sewage Disposal, Vol. II., pp. 98-108; [cd. 1884] 1904.

* Report 4, Vol. II., [cd. 1884] 1904.



THE EGREMONT MUSSEL BED AND THE NEIGHBOURING SEWERS.

portion of the Bed occupied by young mussels;

old mussels;

the sewage outfalls.

and that, fortunately, the small mussels on the northern portion are being broken up by the surf.

Four sewers, Nos. 4-7, discharge on the whole bed. Nos. 4 and 6 were discharging crude sewage at the time we were on the bed and the immediate neighbourhoods of these outfalls, particularly that of No. 4, were very foul with accumulations of fæcal matter and watercloset paper, and banked-up amorphous débris.

The mussels collected were rather small but all above gauge size (2 to $2\frac{1}{2}$ inches long). They, most of them, contained pea crabs, but were apparently healthy and not ill-nourished. The mantles were filling up and contained plenty of spawn. They were examined, and the primary cultures made, on the same night on which they were collected.

After 24 hours the primary neutral-red agar plates were counted with the following results:—

Mussel.	Number of Colon-like Colonies.
1	About 900
2	„ 600
3	„ 1000
4	„ 250
5	„ 300
6	Very numerous, colonies run together.
7	Over 1000
8	Numerous, colonies run together.
9	About 250
10	Numerous, colonies run together.

Results of the anærobic milk cultures: All the milk tubes showed the typical "enteritidis reaction," that is, clotting, acid formation, and subsequent bleaching of the litmus, abundant gas formation so that the clot was broken up, and a fœtid smell. The spores of *B. enteritidis sporogenes* (or of some other anærobic spore-forming bacillus) were therefore present.

Fifteen of the colon-like colonies were then selected and sub-cultured, with the result that *B. coli* was found to be present on every plate. At the least one-third of the colonies were proved to be those of *B. coli.* Therefore in $\frac{1}{10}$ to $\frac{1}{5}$ cc. of the stomach contents of the worst mussel examined, that is in a good-sized drop, there were present about 300 colon bacilli.

A great number of other microbes were also present. Many of these grew on neutral-red agar as white colonies. This colour of colony on this medium is characteristic of the typhoid bacillus. Several white colonies were, therefore, sub-cultured, but *B. typhosus* was not present. None of these white colonies was identified with certainty. Staphylococci were abundantly present in most of the plates, but these microbes have no special significance and are widely distributed. *B. acidi lactici* was also numerous. Here again this bacillus has no dangerous significance. It is very numerous in sewage but need not necessarily be derived from the human intestine.

The analysis showed, then, that the Egremont mussel bed was excessively polluted, and that the mussels were feeding on the sewage matters.

The Rock Ferry Mussel Bed.

The Rock Ferry bed is not of much economic importance, but since mussels are occasionally gathered from it and sold as human food it was thought advisable that it should be examined. I did not inspect this area myself, but the late superintendent and Mr. Eccles inspected it several times, and early in 1903 a sample of mussels, gathered from it by Mr. Eccles, was sent to the Laboratory for analysis. It was evident on inspection that the bed was greatly polluted. Mr. Dawson informed me that the shellfish in one particular place were living in what was practically a pool of sewage.

The situation of the bed is shown on the sketch chart on page 72. There are two sewers (Nos. 1 and 2) near the New Ferry pier, one on each side, and one (No. 3) close to the South end of the mussel bed itself. The latter lies just to the South of the Rock Ferry pier. All these sewers discharge near the limit of low water.

The first sample of mussels was examined on November 5th, and because of the pressure of other work which could not be postponed a provisional analysis only was made, and this was submitted to the General Purposes Sub-Committee meeting in November, 1903. This analysis showed that the shellfish on this bed were grossly polluted. On 11th Oct., 1904, however, another sample was obtained by Mr. Eccles and sent to me. This sample was obviously taken from a different portion of the bed than that from which the first sample was collected, and the fish did not afford evidence of such a degree of pollution as the first lot. The results of the analysis are:—

RESULTS OF THE PRIMARY CULTURES ON NEUTRAL-RED AGAR PLATES.

Mussel.	Number of Colon-like Colonies.
1	82
2	7
3	200
4	46
5	120
6	146
7	Very numerous, colonies run together.
8	200
9	196
10	200

Anærobic cultures for the demonstration of *B. enteritidis sporogenes* were also made from the 10 mussels examined above. All these fish, except No. 4, gave the typical enteritidis reaction. In No. 4 the milk was clotted, but the peculiar torn condition of the clot was not produced.

Nine of the colon-like colonies on the primary neutral-red plates were inoculated on agar to obtain pure sub-cultures, and the latter were then tested in detail. Four of these colonies gave all the reactions for *B. coli*, so that nearly half of the colonies counted were those of this latter bacillus.

The method of analysis recommended by Dr. A. C. Houston* was also utilized in this case. One mussel was extracted, with all precautions to ensure sterility of the vessels, apparatus, &c., and was beaten up with 100 cc. of

*2nd Report Roy. Comm. Sewage Disposal, p. 135 [cd. 1178], 1902.

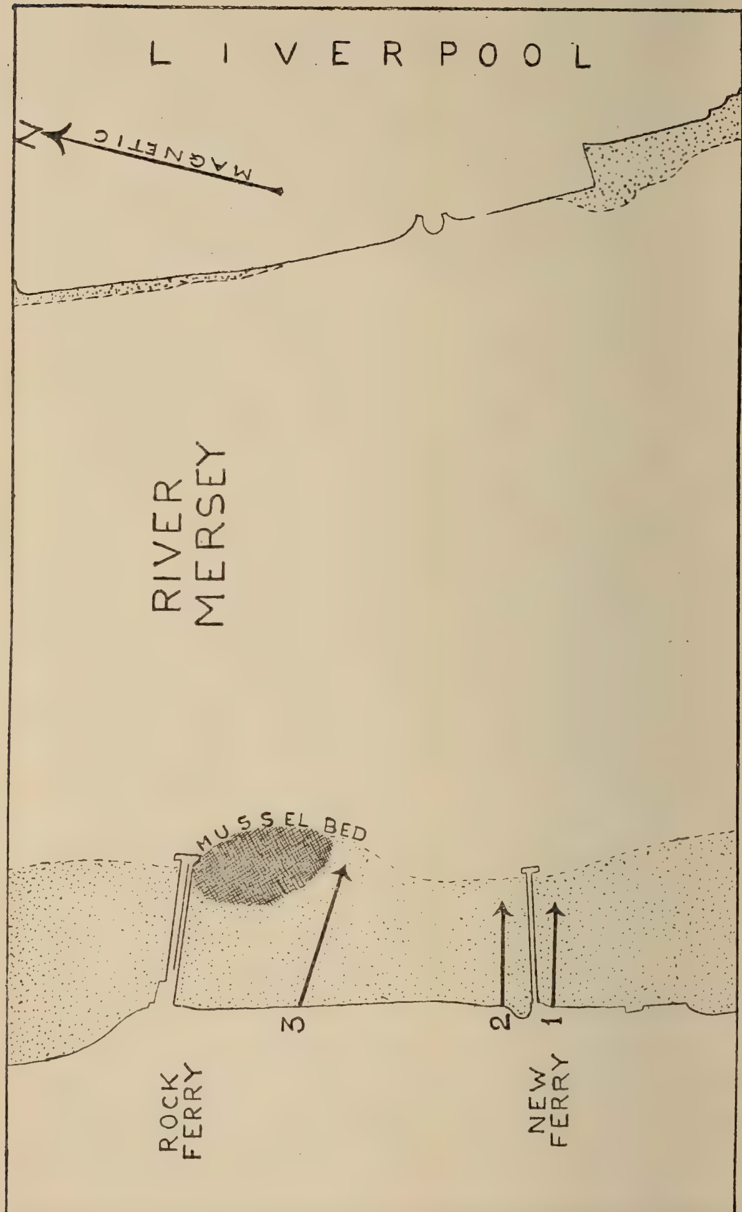


Fig. 4. Chart of the River Mersey, near Rock Ferry, showing the mussel bed and the positions of the sewer outfalls.

sterile water. One cc. of this was then inoculated in 99 cc. of sterile water, and 1 cc. of this latter dilution was again inoculated in other 99 cc. of sterile water. By repeating this process four liquids were obtained:—

Dilution	I.—1 cc.	contained	$\frac{1}{100}$th	part of a mussel.		
,,	II.—	,,	,,	$\frac{1}{1000}$	,,	,,
,,	III.—	,,	,,	$\frac{1}{10000}$	,,	,,
,,	IV.—	,,	,,	$\frac{1}{100000}$	,,	,,

Then 1 cc. from each dilution was inoculated in about 10 cc. of neutral-red agar liquid at a temperature of 42° C., and the latted media were then poured into Petri dishes and incubated. At the same time 1 cc. of each dilution was inoculated in milk tubes, and the latter were incubated anærobically as before.

The results were that the first plate (Dilution I.) showed 12 colon-like colonies, some of which proved on further sub-culture to be those of *B. coli.* The other plates were sterile so far as this microbe was concerned. 1 cc. of Dilutions I. and II. gave the enteritidis test in the typical manner.

Therefore, *B. coli* was present in $\frac{1}{100}$ part of a mussel from the Rock Ferry bed, and *B. enteritidis sporogenes* was present in $\frac{1}{1000}$ part.

The Wallasey Mussel Bed.

It was thought advisable to examine this bed also for evidences of sewage pollution, though I did not expect to find such so marked as in those beds in the estuary itself. Indeed, from its open and exposed situation it was thought probable that pollution by sewage would not be evident here. The bed is an important one; it is of large extent, and at times it is the area of a considerable fishery. Its situation is shown on the chart on next page. It lies far out from shore; extending from near the N.W.

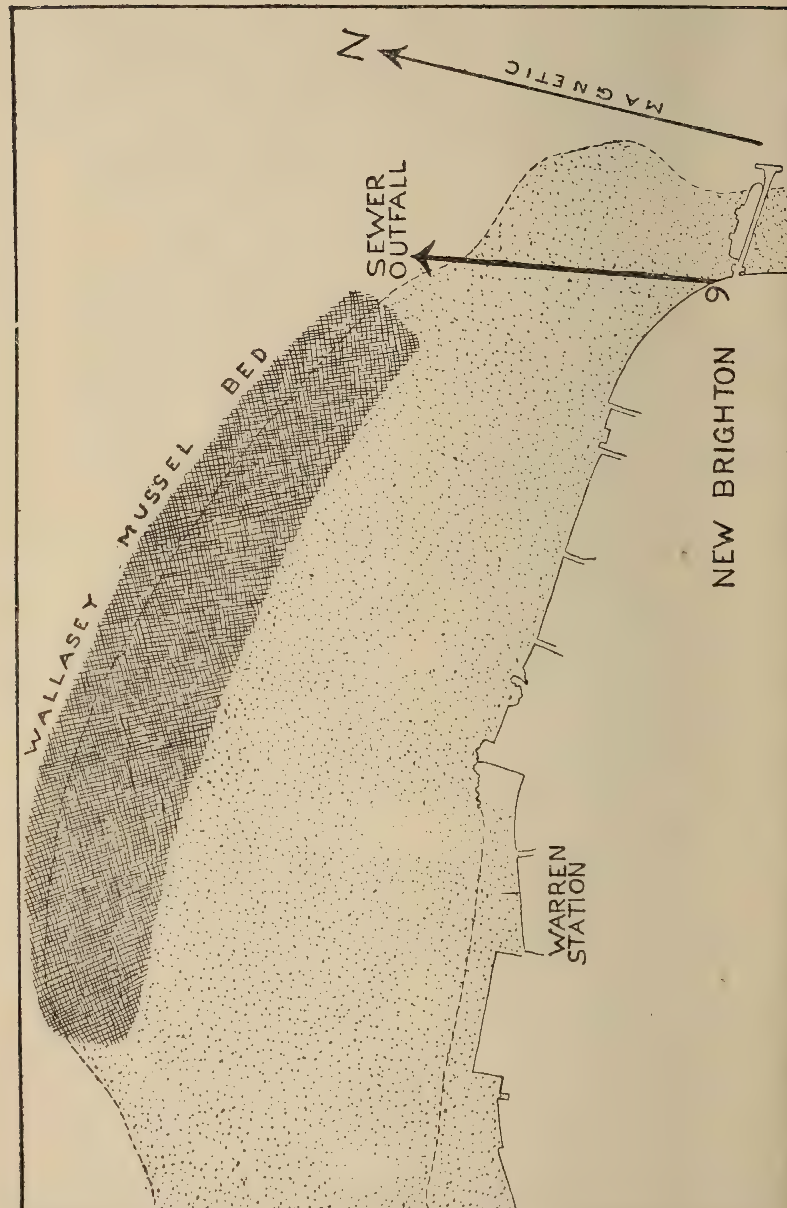


Fig. 5. Chart of the Mersey estuary, showing the Wallasey mussel bed and the adjacent sewer outfall.

corner of the Wirral peninsula to well below Warren station. One sewer (No. 9) discharges untreated sewage at a point rather near to the eastern extremity of the bed. I visited the bed with Mr. Eccles on June 24th of this year. We looked for the usual evidences of sewage pollution (water-closet paper) but could not find any. The bed is very soft, from the accumulation of mud underneath the mussels. Here and there the surf had broken up large portions of this muddy sub-stratum and the mussels were being smothered and destroyed. It is to this cause that the fœtid smell, that could be perceived at times, was due. The mussels were mostly very small, but were well nourished. The sample collected for analysis was taken from every accessible portion of the bed.

Ten mussels were examined with the following results:—

PRIMARY CULTURES ON NEUTRAL-RED AGAR PLATES.

Mussel.	Number of "Colon-like" Colonies.
1	19
2	5
3	0
4	9
5	7
6	11
7	3
8	5
9	21
10	3

Other bacteria, not being those of the colon-group, were numerous, rather more so, perhaps, than in the cultures made from Egremont and Rock Ferry mussels.

Five anærobic milk cultures were also made from mussels Nos. 1, 3, 5, 7 and 9. In all cases the typical enteritidis reaction was obtained.

Fourteen of the "colon-like" colonies were then examined in pure sub-culture by the methods indicated. In 8 of these the reactions characteristic of *B. coli* were obtained. Several white colonies were also examined, and one of these (from mussel 10) gave the following reactions in 24 hours: Bile-salt, glucose broth, glucose broth and mannose broth—acid and gas; sucrose broth and glycerine broth—no reaction; milk—feeble acidity; lactose—no reaction. The organism was a motile bacillus. In its inability to ferment lactose it approaches to the character of the typhoid bacillus. It probably belongs to the paracolon group of microbes.

More than half of the organisms described as "colon-like" are, therefore, *B. coli*.

A further examination of the mussels from the Wallasey bed was made on July 4th. The sample in this case was collected by Mr. Eccles. Dr. Houston's method was adopted with the following results:—

Dilution I.—In $\frac{1}{10}$th part of one mussel there were 12 colon-like colonies.

" II.— " $\frac{1}{100}$ " " " was 1 colon-like colony.

" III.— " $\frac{1}{1000}$ " " " " 1 "

" IV.— " $\frac{1}{10000}$ " " " " 1 "

" V.— " $\frac{1}{100000}$ " " " were no colonies whatever.

One colony sub-cultured from I. was *B. coli*; the colonies present in II. and IV. were also *B. coli*. This microbe was, therefore, present in $\frac{1}{10000}$th part of a mussel.

The enteritidis reaction was observed only in dilutions I. and II.

The mussels present on the Wallasey mussel bed are, therefore, polluted by sewage, though the degree of pollution is far less than in the cases of the Egremont and Rock Ferry mussels.

III. The Mussel Beds in the Lune Estuary.

The mussel beds in the estuary of the Lune are of comparatively little commercial importance; the salmon fishery in this arm of the sea is of immensely greater value. In 1902, however, petitions were presented to the Lancashire County Council by the Conservators of the Lune, Wyre, Keer and Cocker fresh water fisheries, and also by fishermen from the areas round the mouth of the Lune, complaining of the polluted state of the water in the river. It was claimed that there was deterioration of the salmon fishery, and that the health of those engaged in fishing in the river, and the public health generally, was likely to suffer in consequence of the increasing contamination of the tidal waters of the Lune estuary by the crude sewage of the town of Lancaster. An exhaustive inquiry into the whole question of the pollution of the river was, therefore, made by Dr. Sergeant, Medical Officer for the administrative County of Lancaster, and a report on the subject was presented to the County Council in April, 1904. The topographical conditions were studied by Dr. Sergeant, and chemical analyses of samples of water from various parts of the river were made by Mr. Halliwell, of the Ribble Watershed Department. The late Mr. Dawson and Mr. A. Scott also made an inspection of the mussel beds at the mouth of the estuary, and Mr. Scott came to the conclusion that there were abundant local evidences on the ground of sewage contamination.

Early in the year Dr. Sergeant requested me to undertake a bacteriological examination of the mussels from the area in question, and a report was prepared which was submitted to the County Council in April. Professor Delepine of the Owens College, Manchester, also made an examination, both bacteriological and chemical, of the deposits on the banks of the river, samples of soil, water and sewage, and in his report, which was also submitted to the County Council, he came to the conclusion that there was "clear evidence of fæcal pollution of the banks of the River Lune, between Lancaster and the sea."

There are two mussel beds at the mouth of the estuary, one at "Crook Skear," about a mile below Glasson Dock, and another on the opposite bank of the river along the course of the training wall which extends from Bazil Point South towards Sunderland Point. Compared with the great mussel beds in Morecambe Bay neither of these is of much commercial importance, but it appears that the fishermen in the neighbourhood rely on them for at least part of their livelihood during the winter season. Deterioration of these beds is, therefore, a question of some local importance, and in addition, the question of the communication of disease by means of the sale for food of these shellfish is also of great importance. Fourteen sewers, mostly over 12 inches in diameter, discharge sewage in a crude state, from a population of over 42,000 persons residing in the town of Lancaster and adjacent villages. One of these sewers discharges the untreated refuse produced in the Lancaster Infectious Diseases Hospital.

Two samples of mussels were collected by Mr. J. E. Gee and sent to me on February 10th, 1904. One of these was from Crook Skear and the other was from Bazil Point. They were examined immediately on

receipt, and the primary cultures made at once. The mussels from Crook Skear were about $2\frac{1}{2}$ inches long, and those from Bazil Point were a little smaller. All were apparently healthy and well nourished. Six fish from each sample were analysed.

The results of the primary cultures on neutral-red agar were as follows:—

Mussel.		Number of "Colon-like" Colonies.
Mussels from Crook Skear.	1	General fusion of colonies.
	2	30
	3	29
	4	6
	5	General fusion.
	6	do.
Mussels from Bazil Point.	7	31
	8	2
	9	1
	10	12
	11	10
	12	23

In addition to the above, cultures of the water in the shells were also made by the same method. About 0·25 cc. of the water was inoculated on the surface of neutral-red agar plates.

Mussels 13 to 15 came from Crook Skear, and 16 to 18 from Bazil Point.

The results of these latter cultures are as follows:—

Mussel.		Number of "Colon-like" Colonies.
Crook Skear.	13	Sterile.
	14	3 small fused areas.
	15	1 small fused area.
Bazil Point.	16	3
	17	3
	18	Sterile.

Colonies representative of those ascribed to "colon-like" organisms were then examined in pure sub-culture. Eleven colonies of this kind were examined with the result that 4 from the stomach contents, and one from the water in the shells proved to be those of *B. coli*. *B. paracolon*, an equally significant organism, was also isolated from mussels 6 and 11. Staphylococci, *B. lactici*, *B. capsulatus* and some aberrant organisms were also isolated.

Anærobic milk cultures from the stomachs of mussels 1 to 12 were also made. All these without exception yielded the typical enteritidis reaction.

At the request of Dr. Sergeant I made a further examination of the Crook Skear mussel bed. On February 19th Mr. Scott, Mr. J. Wright, Chief Bailiff of the Northern Division, and I visited this bed. We went on the Skear about the time of low water. There were few, if any, evidences of sewage pollution on the mussel bed itself, but on the sands above the skear, and particularly on the banks of a large gutter which runs there, we saw plenty of shredded paper, even distinct accumulations of this in places. Mr. Wright told us there had been much flood water in the Lune previous to our visit, and it is,

therefore, probable that after a dry season the above evidences of sewage pollution would have been more apparent. It was impossible to get to Bazil Point at the time, but a sample of mussels from Crook Skear was packed in a sterile tin, and samples of the paper on the sands were put into a sterile bottle. The material so collected was examined and cultivated next morning.

The primary cultures on neutral-red agar from six of these mussels gave the following results :—

Mussel.	Number of "Colon-like" Colonies.
1	10
2	5
3	15 (also several diffuse red patches)
4	6 (ditto ditto)
5	14
6	22

Ten of these colonies were selected for further study in pure sub-culture. Five of them were proved to have been produced by *B. coli.*

The paper collected was then examined. Plates of neutral-red agar were poured and small pieces of the paper were taken up by sterile forceps and stroked along the surface of the medium. The plates were then incubated in the usual manner. The results were :—

Plate.	No. of "Colon-like" Colonies.
1	7 (also 3 white colonies).
2	14 (with many white colonies)
3	Numerous and fused along the strokes.

Plates 1 and 2 contained *B. coli.*

Various white colonies were also studied in pure sub-culture, but none was identified. A bacillus was isolated from plate 2 which produced simple acidity in bile-salt, glucose broth, and in glucose broth, no reaction with lactose, mannose, sucrose, or glycerine, and acidity and clotting in milk. Mr. Lewis, of the Pathological Department in the University of Liverpool, informed me that those reactions are identical with those produced by a bacillus which he isolated from one of the South African War infected Army blankets, examined some time ago. This, therefore, is most probably also a microbe of intestinal origin.

All the anærobic milk cultures made gave the typical enteritidis reaction.

It was concluded then that the mussels from both Crook Skear and Bazil Point were infected with sewage matters. This conclusion is thoroughly borne out by Mr. Scott's and my own examination of the conditions of the beds, and by the study of the bacteria adhering to the paper picked up from the sands. At the same time comparison with the results obtained in the analysis of the Egremont mussels shows that the degree of pollution of the Lune mussel beds is not excessive.

IV. Deep-Sea Oysters.

During the summer of 1904 Professor Herdman suggested that a bacteriological examination of oysters and other shellfish than mussels, from sources which might reasonably be regarded as free from sewage pollution, should be made in order to afford a comparison with the results obtained from mussels taken from inshore areas. Accordingly I collected and examined several samples of oysters from various off-shore grounds. The first analysis

of this kind that was made was one of the stomach contents of shrimps from the Blackpool closed ground. On 11th June, 1904, while trawling there I took back half-a-dozen shrimps to the laboratory. The stomachs and livers of these animals were dissected out with sterile scissors and forceps and put into a small beaker and mixed with 6 cc. of sterile water. Various quantities of this emulsion were then inoculated in neutral-red agar liquid at 42° C. This was poured into Petri dishes and allowed to set and then incubated. The results were:—

	Number of "Colon-like" Colonies.
2 cc. of emulsion (= 1 shrimp)	1 surface, 4 deep.
1 ,, ,, (= 1 ,,)	1 ,, 3 ,,
0·1 ,, ,, (= $\frac{1}{10}$th ,,)	1 deep.
0·01 ,, ,, (= $\frac{1}{100}$th ,,)	Sterile.

Six of these colonies, ascribed to *B. coli* (or its congeners) were then studied in pure sub-culture. In no case were reactions typical of this organism obtained. All the reactions obtained were such as might be ascribed to staphylococci, or organisms of ubiquitous distribution. The results of this analysis were, therefore, ambiguous, and no opportunity has yet been found to repeat it.

Deep-sea Oysters from near Liverpool N.W. Lightship.

On July 6th, 1904, a special visit was made in the "John Fell" to the grounds in the vicinity of the Liverpool N.W. Lightship in order to get a sample of oysters for analysis. This ground was selected because oysters

in abundance can always be obtained here, and further because it is a good distance (12 miles) from land, and so fairly free from the influence of fresh water which might contain sewage microbes. Nevertheless, we expected to find some traces of sewage bacteria here, since the hoppers carrying dredged material from the Mersey Docks deposit this not far from the lightship. Trawls or dredges used here usually bring up broken earthenware and other like débris. After sevéral trials with a large dredge we found plenty of oysters a mile or two South by West of the ship, in five fathoms of water, and on a gravelly bottom. About a dozen were brought back the same evening and stored during the night in a large clean glass vessel, standing in a large basin and surrounded by broken ice. The primary inoculations were made early next morning. The oysters were well scrubbed under the tap and opened with a sterile oyster knife. They were all large and very fat fish. The liquid in the pallial cavity was then drained off; a crucial incision was made through the visceral mass so as to open up the stomach cavity, and from the liquid which filled up the cut so made 0·25 cc. was withdrawn with a sterile pipette and inoculated on the surface of neutral-red agar. An equal quantity was also inoculated in milk tubes and incubated anærobically in the usual manner.

The results of the primary cultures were:—

Oyster 1.—Sterile.
,, 2.—One colony (colon-like).
,, 3.—Sterile.
,, 4.—One colon-like colony.
,, 5.—Sterile.
,, 6.—Sterile.

The two colonies, both of them large, red and rapidly

growing, were then sub-cultured on a nutrient agar and examined in detail. The results were:—

	Motility.	Bile salt broth.	Glucose broth.	Lactose broth.	Mannose broth.	Sucrose broth.	Glycerine broth.	Milk.
Colony 2	+	Acid and very slight gas.	Acid, gas.	O.	Acid, gas.	Acid, gas.	O (after 6 days).	Acid.
Colony 4	—	Acid, gas.	Acid, gas.	Acid, gas.	Acid, gas.	Acid, gas.	Acid, gas (in 24 hrs).	Acid, clot.

The broth and milk cultures were examined after 24 hours, but the glycerine cultures after 6 days.

Neither of these organisms is *B. coli.* Colony 4 is most probably that of *B. acidi lactici*, and colony 2 is possibly that of *B. cloacæ.* McConkey concludes that this latter microbe is only an attenuated form of *B. coli.*

Three oysters were tested for the enteritidis reaction:

	Enteritidis reaction.
Oyster 2	+
,, 4	+
,, 6	+

Oysters from near Morecambe Bay Lightship.

On July 21st, 1904, a visit was paid to this ground for the purpose of getting oysters for analysis. A trawl net was used, and was shot 1 mile S. by W. of the vessel and dragged to the East. Over three dozen oysters were taken, and a dozen were brought back to Liverpool the same evening and stored as before. This ground is far removed from sewage contamination; it is about 16 miles from the

nearest land, and is almost in the fairway of the Channel. The depth was 13 fathoms, and the bottom muddy. No land débris was taken in the net.

Six oysters were examined early on the following day—two of these had the gills choked up with a large mass of "black-spat" larvæ. One had vivid green patches over the region of the viscera and heart.

A larger quantity than usual of the stomach contents (0·3 to 0·5 cc.) was removed for inoculation. Six neutral-red agar plates were made and incubated for 48 hours. At the end of this period the plates were sterile.

B. coli (and other sewage) organisms were therefore, absent.

A similar quantity of stomach contents was inoculated in milk tubes, and incubated anærobically. The results were:—

	Enteritidis reaction.
Oyster 1	—
,, 2	—, milk discoloured, but not clotted.
,, 3	+
,, 4	—
,, 5	—, milk discoloured, but not clotted.

On September 22nd, 1904, another visit was made in the "John Fell" to Morecambe Bay lightship. The trawl was shot about 5 miles South of the ship. About a score of large oysters were obtained, and from these six were taken at random and put apart for analysis. They were allowed to stand on deck for about 18 hours before being landed at Piel. They were then analysed (at the Piel laboratory) as before.

Similar results were obtained with the neutral-red agar plates. All the cultures were sterile.

Six anærobic milk cultures were also made, with the following results:—

	Enteritidis reaction.
Oyster 1	—
„ 2	Acid and slight clotting.
„ 3	—
„ 4	—
„ 5	Acid and slight clotting.
„ 6	—

This is the first analysis made in which one, at least, of the shellfish examined did not give the typical enteritidis reaction.

General Remarks.

The general conclusion that may be drawn from the above series of analysis, then, is that:—

1. There is excessive pollution of the mussels growing on the Egremont mussel bed, by sewage microbes of human intestinal origin;
2. The mussels from the Rock Ferry mussel bed are also dangerously polluted, but not to the same degree as in the case of the Egremont fish.
3. The mussels from the Wallasey and Lune areas are polluted, though not at present to such a degree as to cause very serious apprehensions of danger to the public health;
4. Oysters taken from off-shore fishing grounds are unpolluted.

These conclusions are based on the presence of the microbe *B. coli* in the stomachs of the shellfish examined. This organism is not necessarily to be regarded, in itself, as a dangerous microbe; but, being derived from the human intestine, it indicates the possibility of the shellfish in which it is found harbouring, at any time, pathogenic microbes, which may communicate disease. The bulk of expert opinion nowadays is that *B. coli* is to be regarded as the best indication of sewage pollution in the medium (water on the stomach contents of shellfish) in which it is found. It is frequently suggested in the evidence submitted to the Sewage Disposal Commission, that a different interpretation may be placed on the presence of *B. coli* in such media; that it may possibly be derived from the excrements of sea birds or even of sea fish, and that, if this be the case, its presence may not be of serious significance. I am not aware, however, of any observations which tend to support this (purely *a priori*) view. The shrimps from Blackpool closed ground, or the oysters from the off-shore grounds, which I examined, most probably would have contained *B. coli* if their contamination from such sources had been at all likely. Nevertheless, except in the case of the oysters taken from near the new lightship, in Liverpool Bay, the whole colon-group of organism was absent.

The question of a permissible standard of impurity has frequently been discussed, and we must conclude that the creation of such is impracticable. In the case of the Egremont mussels, from 250 to over 1,000 microbes belonging to the colon group were present in $\frac{1}{10}$th cc. of the contents of the stomach of a single mussel, and of these at least one-third were the true *B. coli*. On the other hand, we have the oysters from the N.W. lightship, in six of which only two colon-like organisms were found,

and neither of these was *B. coli* in the strict sense. In the former case there was independent evidence of the dangerous condition of the shellfish, and the number of colon microbes present was so great that we must conclude that the degree of contamination greatly exceeded any standard number of bacteria that might reasonably be agreed upon. In the latter case any sewage contamination to which the shellfish were subjected was remote in point of time, and the number of colon bacteria was so small that we must conclude the degree of contamination was less than any reasonable standard of impurity. But what is to be said of the condition of the Wallasey mussels? Here from 3 to 21 colon-like microbes were found in $\frac{1}{10}$th (roughly) of the stomach contents of one fish, and of these about one-half were true *B. coli*. Some doubt might be felt here as to whether or not the degree of contamination was a dangerous one. But in this case the pollution is remote; the mussel bed is, indeed, near a sewer outfall, but the liquids discharged by the latter do not flow directly on to the bed, but are probably widely distributed by the strong ebb tides running in this locality. We know that the water of the Mersey does contain *B. coli*, and it is probable that the mussels are infected from this water, some of which probably flows over the bed with every ebb tide. There is no evidence of any disease being communicated by the consumption as food of these shellfish, and, considering that the pollution is remote, and that the actual numbers of colon bacteria obtained from each fish are small, it is to be concluded that the degree of contamination is not a dangerous one. It must be remembered, too, that probably most, or all, shellfish beds round such a thickly-populated area as the English seaboard are polluted by sewage to some extent.

It will be seen that such a comparative series of analyses indicates the value of the method adopted here for the quantitative determination of the number of sewage organisms present in shellfish. Where topographical and other considerations render the pollution of the shellfish most probable, there we find that the numbers of colon bacilli present in the stomachs of the molluscs are the greatest; and conversely where, as far out from land, we should expect great freedom from pollution, colon bacilli are either very rare or are absent altogether. The direct incubation of material of this kind on neutral-red bile-salt, lactose agar, in the manner indicated here, is indeed the simplest, and apparently the most reliable biological test for the presence of sewage microbes that has yet been devised. A negative result is, undoubtedly, a sure indication of freedom from such contamination.

It is to be noted, too, that the enteritidis test is far less useful as an index of contamination than the *B. coli* one. In all the analyses made here, some reaction (though not always a "typical" one) has been obtained from anærobic milk cultures, though bacilli of the colon group may have been absent altogether. This is to be expected, for in such tests we cultivate the spores of an obligatory or facultative anærobe of some kind, and these spores are far more resistant than the colon bacilli, and most probably have a very general distribution, though they do not form a part of the normal bacterial contents of uncontaminated shellfish.

NOTE.—A question recently raised by the Chairman of the Gen. Purp. Sub-Com. was referred to me by Dr. Jenkins, viz.: Are sewage-contaminated mussels unhealthy? I have never seen any certain indications that a considerable degree of admixture of sewage with the water in which mussels are living does any harm to the latter. They indeed appear at times to thrive on sewage.

EXPERIMENTS IN MARKING PLAICE.

By Jas. Johnstone.

During the autumn of 1904 the Scientific Sub-Committee of the Lancashire and Western Sea Fisheries Joint Committee considered a suggestion made to them with regard to the marking of living sea fishes, and authorised the expenditure of £30 on experiments in this direction, with special reference to plaice and soles. The marking and liberation of living fishes is, of course, an old idea, but until a few years ago it has not been carried out on a really large scale. Many experiments have been made on salmon, but with somewhat ambiguous results. About ten years ago Dr. Fulton made some experiments of this kind on the East Coast of Scotland with regard to plaice and obtained valuable results.* When the International Scheme of Fishery Investigations was adopted in 1902 by the North European countries, it became possible to carry out such experiments on a scale commensurate with the importance of the object, and various methods of marking fishes were elaborated. England, Holland, Germany, Denmark and Belgium have all taken part in these investigations, and up to the end of 1903, 6,239 living plaice were marked and liberated in various parts of the North Sea. Of these, 889 were recovered up to the end of June, 1904.†

Various "marks"—vulcanite studs with indiarubber collars, aluminium rings, &c.—have been employed in

* Report Fishery Board for Scotland for 1892, Pt. 3, pp. 176-196. 1893.

† These experiments are still in progress, and the full results are not yet published. See, however, the Publication of the Council Permanent pour l'exploration de la Mer, Rapports et Procès-verbaux Copenhague, Vol. 2, 1904, p. xxviii.; also Mr. Garstang's evidence Select Committee Sea Fisheries Bill (H. L.), 1904.

different countries, but the most successful form of mark seems to have been that first employed by the Dutch investigators and elaborated later on by the English section of the international fishery research organisation, and adopted now by England, Sweden, Holland and Belgium.

A photograph of a plaice bearing a mark is given in Pl. II.

This consists of a bone button and a numbered brass label fixed to the body of the fish by means of a silver wire. The wire is about one inch in length and is ·85mm. thick. A small loop is made at one end and is bent down at right angles to the rest of the wire. A bone button about $\frac{5}{8}$ inch in diameter is threaded on this wire. A narrow hole is pierced through the body of the fish (flat fishes only) about midway between the head and the tail and about 1cm. below the insertion of the dorsal fin. The wire is then pushed through this hole so that the bone button is on the blind side of the fish and the brass label is then threaded on the wire so that it lies on the ocular side. The free end of the wire is now bent into a small closed loop with round-nosed pliers, and the loop is turned down at right angles. In making these experiments the fishes are caught by a wide meshed trawl net hauled for an hour so as to catch comparatively few fishes, and not to encumber and damage them with a mass of invertebrate and other debris. The fish suitable for marking are rapidly picked out as soon as the net is hauled, and are at once put into tanks through which a continual stream of sea water circulates. After a few hours any injured or obviously unhealthy fish are picked out and rejected. The others are marked. One man takes the fish from the tank, measures it, calls out the size, and hands it to the operator. Another man records the size of the fish and the number of the label to be used, which he hands to the

operator, who then affixes it to the fish and replaces the latter in another tank. With a little practice all this takes rather less than a minute. If the fish is kept for an hour or two so as to recover from the inconvenience of being caught, and if the hole in its body is neatly made so as to avoid bleeding, it appears to experience no discomfort. The marked fish are then kept in the tanks for some hours so as to observe whether any ill effects have followed the operation. They are then put into a large bucket which has a "kicking-rope" attached, and this is lowered overboard (the vessel being slowed down) and "tipped" so as to liberate the fish. When the fish are marked in cold weather, no difficulty whatever has been experienced in catching, keeping, and liberating them in first-class condition.

For all particulars as to the above methods, and for our first supply of the marks, I am indebted to Mr. W. Garstang, of the Marine Laboratory at Lowestoft, and to his assistant, Mr. J. O. Borley.

We began to mark plaice and soles in October, 1904, and the following is a list of the places and dates, at and on which the fish were liberated.

1. Luce Bay, October 18, 1904—50 plaice marked and liberated.
2. Ramsey Bay, half-way between Point of Ayre and Bahama Lightship, October 19, 1904—34 plaice.
3. Near Puffin Island, North Wales, November 12, 1904—2 soles, 42 plaice.
4. $1\frac{1}{2}$ miles N.W. of Great Orme's Head, North Wales, November 12, 1904—5 soles, 49 plaice.
5. 2 miles N.W. by W. of Newcome Knoll Buoy, Liverpool Bay, November 12, 1904—53 plaice.
6. Blackpool Closed Ground, November 13, 1904—5 soles, 78 plaice, 1 flounder.

7. Luce Bay, November 18, 1904—1 cod, 71 plaice. So that 377 plaice, 12 soles, 1 flounder, and 1 cod have been marked and set free.

In order to advertise the experiment, 1,000 small posters, and 2,000 handbills were printed. These were distributed to the fishery officers of the Lancashire and Western, the Cumberland, and the Milford Haven Sea Fisheries Committees, to coastguard officers, harbour and pier masters, and others. The owners of trawling vessels also distributed a number of these notices among the masters of their boats, and a large number were sent to fishermen. The Fishery Board for Scotland kindly allowed us to make use of their "correspondents" in the Ballantrae District (Ayr to the Solway Firth), and we are arranging for the officers of the Irish Department of Agriculture and Technical Instruction to co-operate in the same way. Several members of this Committee, and other gentlemen are also most kindly assisting us by receiving and forwarding marked fishes recaptured by fishermen. A reward of 1s. 6d. plus the value of the fish is paid for the fish, the mark, and full information as to the place and date of capture; 1s. is paid for the label and information, without the fish; and 6d. is paid for the label alone.

The success of such an experiment as this must obviously depend on the extent to which it is made known. The Lancashire and Western Fisheries District is now thoroughly organised, contiguous authorities are most willing to co-operate, and the fishermen exhibit so much interest in these experiments that we hope for successful results in due course.

It would, of course, be premature at this stage of the experiment, to discuss the results attained. Obviously marking experiments must be carried out for at least one

complete year, for the migrations made by fishes will depend to a great extent on the season. If rate of growth is to be studied, at least one or more years must elapse before reliable conclusions can be drawn. Growth does not go on in the winter months, and none of the fishes recovered so far has exhibited any increase in weight or length.

The results obtained up to the present time (February, 1905) may be stated very briefly:

Considering the fish liberated off the Lancashire and Welsh coasts alone, 21, or about 7 per cent., were recaptured during the first month.

Of the fish liberated on the Blackpool Closed Ground, a great proportion must have gone into Morecambe Bay, as far North as Grange, and have been caught by trawls and stake nets in this area. One went South and was caught off the Ribble estuary.

The fish liberated at Newcome Knoll have for the most part apparently gone inshore. Most went into Rock Channel and on to the Wallasey and Leasowe shore; one travelled to the Gut Channel off Southport, and one as far North as the River Lune.

Of the fish liberated off the North Coast of Wales, only two have been recaptured any distance away from the place where set free: these were caught in the estuary of the Dee. The others re-caught were mostly taken in Red Wharf Bay.

Several exceptional journeys have been made. Thus a plaice referred to above travelled from Newcome Knoll Buoy, off the Mersey, to No. 4 Buoy in the Lune estuary, a distance of about 35 miles in 20 days. Another plaice set free off Blackpool was caught by a Fleetwood smack 6 miles W. by S. of Blackcombe, on the Cumberland coast. This fish had travelled 30 miles supposing, what

is very improbable, that it took the shortest route, in at the most 15 days. A more exceptional journey was made by another plaice liberated on Blackpool Closed Ground on November 13th. This fish was taken by a Hoylake smack 7 miles off the Isle of Man on December 8, having travelled at the least 40-50 miles along the inshore waters in about 19 days. A Newcome Knoll plaice was also taken on the bank between Maughold Head and the Selker lightship by one of Mr. Knox's trawlers on 24th December, 1904. This fish had travelled at least 60 miles from the place where it was liberated.

We are greatly indebted to those who have taken the trouble to forward the recaptured fishes, particularly to Captain Wignall and to Messrs. Eccles, Wright, Gardner and Jones, officers of the Committee. Messrs. Dean, Garnett and Harley, members of the Committee, and Mr. R. Knox, of Douglas, have also assisted us greatly. Mr. Holmes, Chief Inspector in the Cumberland District, and the officer in charge of the Coastguard Station at Drummore, Mull of Galloway, have also given much assistance.

The following is a statement of all the fish recovered up to the time of going to press:—

Place where Liberated.	Place where Recaptured.
Luce Bay	3 in Luce Bay. 2 in Solway, near Annan.
Ramsey Bay	1 slightly offshore from the Bay.
Near Puffin Island	8 in Red Wharf Bay. 2 in the Dee Estuary.
Near Newcome Knoll Buoy	2 in Red Wharf Bay. 2 on shoals near North end Isle of Man. 1 in Menai Straits. 1 in Ribble channels. 1 in Morecambe Bay. 4 off Wallasey shore.

Plaice, marked and liberated at Newcome Knoll Buoy, off River Mersey, on November 12th, 1904, and recaptured at No. 4 Buoy in River Lune, on December 2nd, 1904.
(Photograph by A. Scott.)

PLACE WHERE LIBERATED.	PLACE WHERE RECAPTURED.
Blackpool Closed Ground ...	12 in Morecambe Bay.
	2 in Ribble channels.
	1 near Great Orme's Head.
	1 in the Dee Estuary.
	1 off Blackcombe.

Considering fish liberated and recovered in the waters of the Lancashire and Western Sea Fisheries District, we find that a little over 16 per cent. have been recovered at the time of going to press (February, 1905)—that is within the three months after liberation.*

*Note added in press.—100 more plaice have been marked and liberated since the above was written. About twenty more fishes, belonging both to the first lots set free, and to this latter lot, have been recovered in addition to those noted above. One was sent from a fishmonger's shop in Leicester. One of the fish set free off Puffin Island was recovered about the middle of February in Pinfold Channel, off Lytham, by Mr. Chris. Whiteside.

INTERNAL PARASITES AND DISEASED CONDITIONS OF FISHES.

By Jas. Johnstone.

Trematoda.

Distomum (?) *valdeinflatum*, Stossich (Pls. IV., V., figs. 9, 10, 14 and 15).

(From muscles of *Pleuronectes limanda*.)

One of the fishermen* who attended the Piel Classes in the spring of 1904 told me that, about that time, many dabs caught in the neighbourhood of Blackpool were very thin and emaciated, and had white spots in their flesh. Suspecting the presence of sporozoan parasites, I asked Captain Wignall to try and procure me a few specimens of the fishes in question, and in the course of a week or so I received from him about half a dozen smallish fishes, all of which were infested with some kind of parasite which gave the flesh, in some cases, the appearance of "measly pork." One or two specimens in particular were badly infected, and were very thin indeed for a dab at the end of the spring. In November, 1904, again, while trawling in Luce Bay, quite a number of dabs were seen to be infected in the same way. These fishes were mostly small (8-11 inches in length, but in one or two cases large dabs (10-13 inches) were also infected, though it was only here and there along the bases of the median fin that the parasites could be seen.

The parasites were situated in cysts, mostly just underneath the skin in the superficial muscular tissue, and principally on the blind side of the fish. They were most numerous along the bases of the dorsal and ventral fins, and were found even between the rays of these fins. Sometimes they were very noticeable, shining with a kind

* Mr. J. R. Parr, of Blackpool.

of pearly lustre. The general appearance of one of these cysts is represented in Pl. V., fig. 15, as seen under a low magnification. The trematode lies inside two cysts, of which the outer is rather thick and fibrous, and is probably derived from the tissues of the host. The inner cyst is very thin and delicate, and is quite transparent. This investment is probably parasitic in origin, and inside it lies the parasite with the anterior extremity bent sharply round the swollen bulbous posterior extremity. Fig. 9 is a view of the trematode within the inner cyst wall, and lying with head bent away from the observer. Fig. 10 again shows one of the worms dissected out from the sac and partially straightened out. The longest diameter of one of the largest cysts is about 2 mm., but most of them are much smaller. The length of the trematode, bent up as in fig. 9, is 0·72mm., and its extreme length, if straightened out, would be about 1·25 mm.

The hinder portion of the body is swollen out into a kind of bulb, and is nearly filled up with a uniform kind of tissue, granular and rather like the yolk material in some eggs. The intestinal branches run back over this for some distance, and end blindly. The anterior portion of the body is cylindrical, and a short neck or constricted portion separates it from the head. This latter portion is very characteristic, because of the double series of spines which surround the terminal mouth. This double arrangement of the oral spines can be seen in every specimen, though at times it is not very distinct. Fig. 14 represents the head seen from the side. The spines are very much stronger than those on the body. Except for these two circumoral rows, the greater portion of the head in this specimen was devoid of spines, though in some others small spines seemed to be present here also. The body as far back as the bulbous portion is closely

beset with small sub-triangular spines, and, though these are also to be seen on the swollen posterior part, they are very much smaller there.

The pharynx is large, oval, and lies some little distance behind the oral sucker. The ventral sucker is rather large, and is situated on a kind of ventral eminence, its longest diameter is the transverse one. The intestinal branches are rather capacious, and are constricted at irregular intervals. In none of the specimens can any very definite trace of the reproductive organs be found, but all those examined were evidently very immature.

I consider this worm to be identical with *Distomum valdeinflatum*, Stossich, though there are, indeed, some differences. It is rather like *D. bicorontum*, Stossich, but is apparently distinct so far as the armature of the neck is concerned. Stossich* found *D. valdeinflatum* in *Gobius jozo*, and Linton† has also recorded it from *Alutera schœpfi* (the orange file-fish, an American Atlantic Monacanthid). In the latter case Linton found the worms in an outer case of connective tissue, surrounding a "thin hyaline sac," in which the trematode was contained. But he found them attached by slender peduncles to the peritoneum of the hosts, whereas in my examples they were imbedded in the flesh. But in one case I found a worm lying in its double sac, which was situated directly beneath the peritoneum.

In the specimens of the dab infected with this distomid larva, which we obtained in Luce Bay on October 18, 1904, the emaciation was not nearly so marked as in those obtained earlier in the year from Captain Wignall. But

* Bull. Soc. Adriat. Trieste, VIII., 1883, p. 114, pl. 1, fig. 4.

† Proc. U. S. Nat. Mus., Vol. XX., No. 1134, p.5 27, pls. 47-8, figs. 10-14, 1-2; 1898.

in these latter specimens the infection was not nearly so strong as in the earlier specimens. The emaciated condition may be compared with the condition of the so-called "acute cestode tuberculosis" produced by feeding experiments with the proglottides of tapeworms. In some experiments made by Simonds and Cobbold*, in 1865, it was shown that the administration with food of the ripe proglottides of *Taenia mediocanellata* to a young, healthy calf produced diseased symptoms, distress of breathing, and other evidences of illness, with a subsequent loss of flesh. The calf recovered latterly, and when subjected to post mortem examination cysticercus larvæ were found in the superficial muscles. The condition of the dabs referred to here is quite analogous, and was probably produced by the ingestion of sporocysts containing distomid larvæ. Here, too, the larvæ were found only in the superficial muscles. Recovery probably takes place, as the larger fishes found infected contained only two or three cysts, and the emaciation was only well marked in those fishes in which the larvæ were present in large numbers.

Gasterostomum gracilescens (Rudolphi) (Pl. IV., figs. 7 and 8).
(From the brain membranes of Gadidæ.)

This worm was first noticed by Mr. Scott in our district in a specimen of the somewhat rare Gadoid, *Phycis blennoides*, which was cast ashore at Piel late in 1903. On dissecting the specimen the brain membranes were seen to be the site of numerous minute round or oval bodies, which were evidently the encysted cercariæ of some trematode. The same bodies were subsequently found round the brain in several haddock dissected in the fishermen's classes of 1903, and small cod $7\frac{1}{2}$-$8\frac{1}{2}$ inches long,

* Proceedings Roy. Soc. London, Vol. 14, 1865, pp. 214-220.

caught in Barrow Channel were infested with the same parasite, and in the same tissues. There is no doubt that these trematodes are common parasites of gadoid fishes.

Pl. IV., fig. 8, represents one of the encysted worms from the brain of *Phycis.* The whole structure is about 0·8 mm. in longest diameter. It is loosely attached to the dura mater, or other membrane, by a fold of the latter. The cyst itself is very thick and tough, and is rather opaque. Within it is the bent up body of the cercaria. In the specimen figured little could be made out of the internal anatomy, except the testes and the cirrus. Others were, however, more advanced, and some had emerged from the sac. In the small cod mentioned above most of the parasites were free from the cysts, but were still very small. In a haddock, which was well infested, the worms were much larger—1·5 to 2 mm., and it is one of these which is represented in fig. 7.

In these worms the reproductive organs are well developed. The cirrus and its sac vary very greatly in length; the testes are large and prominent objects. The uterus is long and twisted, the germarium is small, and lies closely opposed to another structure which I cannot identify. The vitellaria are well developed, but it is difficult or impossible to trace their ducts with any certainty. The anterior sucker is ventral in position, is large and nearly round; the pharynx is situated in the anterior third of the body, and leads into a rather short alimentary canal.

All the anterior portion of the body is closely covered with small backwardly curved spines. These are represented in fig. 11, which shows the margin of the body as seen under a high power lens. On the posterior part of the body these spines are either absent altogether or are very minute.

These encysted cercariæ are the "spheroidal bodies" of Alex. Monro*, figured by him as situated on the brain and along certain cranial and spinal nerves. Their true nature seems first to have been suggested by Sharpey in 1836, and later by H. Goodsir (1844). But R. L. Madox,† in 1867, seems first to have identified them with Rudolphi's *Distoma gracilescens,* which is mature in the gut of *Lophius piscatorius.* Madox apparently made his identification by comparing the structure of his worms with Cobbold's illustration of *G. gracilescens.* The resemblance is striking enough to convince one of the identity of the two worms, though, so far as I am aware, the matter has not been proved experimentally by feeding experiments. Madox gives the name *Gasterostoma neuronaia Monroii* to his organisms.

Lophius is, therefore, the final host of *G. gracilescens* and various Gadidæ—*Gadus, Molva, Phycis,* are the second intermediate hosts. It is possible that the first intermediate host may be omitted, but it is more probable that it is to be found in some species of mollusc on which these fishes may occasionally feed.

Gasterostomum, sp. (Pl. III., figs. 1-6 and 16).

(From the muscles of the plaice.)

A number of small plaice containing encysted *mature* trematodes were obtained while trawling in Luce Bay in October, 1904. These fishes were very abundant: in one haul with a shrimp trawl about 150 small plaice were obtained, and one-third or even more of these fishes were infected. Only small plaice from about $2\frac{1}{2}$ to 5 inches in length contained the parasites, larger forms being apparently free; also the smaller fishes were infected to a relatively greater extent than the larger ones.

* Structure and Physiology of Fishes, 1785, pp. 43 and 106.

† Trans. Roy. Microscop. Soc. London, Vol. XV. (new ser.), pp. 87-99, Pl. VIII., 1867.

It is not easy to figure the general appearance of a fish containing these worms. The cysts are very opaque; the smaller ones being dead white in colour, the larger faintly brown, and some are even dull red in life. In the most highly infected specimens these cysts form a broad band extending along the whole dorsal and ventral body margins, widest about the middle of the body, and tapering away towards each extremity. I counted over 160 such cysts in one plaice $2\frac{1}{2}$ inches long. Some of these cysts contained 10 parasites, and the average could not be less than 5. This band marks the limits of the row of axonosts supporting the fin. Internal or external to this band few cysts are to be found, though occasionally a few may be seen in the muscles of the trunk or in the inter-radial tissues of the fins. The cysts are generally long and narrow, and sometimes fused together. They are present on both sides of the body, though, of course, they are most easily seen on the blind side.

Fig. 1 represents a section through the fin, in a plane transverse to the long axis of the fish's body, and passing through the interspace between two fin rays. On the right side is seen most of a cyst containing 5 parasites, and on the left is a complete cyst containing one parasite, and beneath this part of another cyst. These structures have been formed among the fibres of the muscles which move the fin rays, as in the case of the cyst on the right side in fig. 1, and as they grow the muscle fibres are pushed aside or even partly aborted; or, as in the case of the cyst on the left side, they may be lodged in the tissues between the muscles and the dermis. The cyst wall is tough, and is made up of bundles of fibres pursuing a straight or wavy course. Usually this fibrous wall may be very dense, but at times it is loose and spongy. Generally it is of no great thickness, but adjacent cyst

walls may be connected together by a fibrous tissue, which appears to be continuous with the walls of each cyst. Within the cyst the interspaces between the parasites are filled up by a very peculiar tissue (fig. 16), which, on examination with a high power lens, is seen to be made up of small corpuscles of variable diameter—2·8 to 11μ, average about 7μ. They have a fatty appearance, being comparable to cells, in which large vacuoles of some non-staining material are being formed. The small corpuscles are very dense, vacuolation being absent or nearly so, and they stain a uniform red with Mann's methyl-blue-eosin combination. The larger they are the greater become the vacuoles, and the smaller the amount of the original red-staining substance. The staining reaction is now blue.

Eggs which have been extruded by the parasites are to be found among these corpuscles, and some of the latter may occasionally be seen within the alimentary canals of the former.

The trematode itself is represented in fig. 2, Pl. III. The body is pear-shaped. At the anterior extremity there is a widening of the body forming a kind of collar. The anterior sucker is sub-terminal, is large and oval. The oral sucker is small, and is situated well back behind the middle of the body. In some specimens, cut longitudinally in section, *in situ*, the pharynx is even further back than in the specimen figured. The cirrus is large, and extends forward in front of the pharynx. The uterus is very voluminous, and in some specimens fills up the greater part of the body, preventing the other organs from being seen; it is full of eggs. The testes are large, and are situated anteriorly to the pharynx. Vitellaria are difficult to see, but consist of about half a dozen rounded masses on each side, well in front of the testes; the ducts of the testes cannot be traced with certainty in any of the

specimens on account of the enormously distended oterus, those of the vitellaria can be seen in some specimens. They are represented in fig. 2, Pl. III., but in some cases extend further back than is shown. The eggs are oval, operculated, and without filaments. The longitudinal diameter is 0·037mm., and the transverse is 0·024mm.

The armature of the skin is very peculiar. It consists, not of pointed spines, as in most trematodes, but of scales set deeply in the skin, and with only the margins protruding. Fig. 3 represents the armature of the anterior part of the body, and shows the general size and arrangement of the scales. There are, in addition, a series of true backwardly hooked spines round the head and on the margin of the anterior sucker: these rapidly pass into the ordinary scales, which are distributed very uniformly over the remainder of the body. Fig. 6 is an oblique view of the surface of the skin in a very obliquely cut transverse section, and shows the fish-like overlapping of the scales in some parts of the body. Of course, this overlapping will depend on the degree of contraction of the part examined. Fig. 5 represents part of the skin as seen in a transverse section of the body, and shows the scales cut in section. Fig. 4 is part of a longitudinal section, and shows part of one row of scales in surface view.

Gasterostomum sp.

A "Bucephalus" cercaria form was found by Mr. W. Tattersall, B.Sc., a former student of the Zoology Department at Liverpool University, while dissecting *Cardium edule.* Mr. Tattersall's notes say:—"Found in long, narrow, tapering, and winding sporocysts in the region of the liver and genital organs, and buried in these organs."

All Gasterostoma appear to possess the "Bucepha-

lus" form in the cercaria stages. The larva referred to here is probably *B. haimeanus* of Lacaze-Duthiers, a cercaria stage occurring in *Ostrea edulis* and in *Cardium rusticum*.*

Cercaria fissicauda, La Val.

(From *Cardium edule*.)

A cercaria larva with furcate tail was found by Mr. Scott in dissecting some specimens of *Cardium edule* from Grange-over-Sands. The larva is most probably identical with the species described by the above name, which has hitherto only been recorded from the marine Lamellibranch *Scrobicularia*. Mr. Scott's drawing is reproduced in Pl. III. fig. 13.

CESTODA.

Dibothrium (=*Bothriocephalus*) *punctatum*, Rudolphi (Text-fig. 6).

Turbot in the Irish Sea are nearly always infested with this tapeworm. While trawling in Luce Bay, on October 19th of this year, one of these fish was caught which measured over 24 inches in length. On dissecting it

TEXT-FIG. 6. Head of *Dibothrium punctatus*.

the intestine posterior to the pyloric cæca was found to be almost choked up with a twisted mass of worms belonging to this species. These animals were imbedded in a pearly white mass of chyle, and could only be separated from each other with very great difficulty. Their heads were attached to the walls of the pyloric cæca and the adjacent wall of the intestine.

* Ann. Sci. Nat. Ser. 4, Zool., 1854, pp. 294-302, Pl. 6.

During the same day we caught one brill about 11 inches in length, and the intestine of this fish on being opened was also found to contain one cestode, which was preserved for identification, and is here ascribed to the above species. It was attached to the wall of a pyloric cæcum. The head was buried in a little pit, round which the wall of the intestine was raised to form a prominent papilla. Text-fig. 6 is a view of the head seen obliquely from above, and shows one of the bothria. The dimensions of the worm are as follows:—

Length of head	1·2 mm.
Greatest breadth of head ...	0·32 mm.
Length of a posterior proglottis	0·22 mm.
Breadth ,, ,, ,,	4·0 mm.
Length of the worm	180 mm.

Dibothrium punctatus is very widely distributed. Diesing has enumerated 11 species of European fishes as its hosts, including *Cottus*, *Scorpius*, *Gadus*, *Trigla*, *Rhombus*, and *Pleuronectes*. Linton* records it from several species of American pleuronectids. Its size appears to be very variable. Drummond records a specimen from the brill which was 3 feet in length, but in the turbot the usual length, according to this author, was 8 to 18 inches. The specimen recorded here was 8 inches long, but the above measurements were made on the worm after death and subsequent preservation in formalin.

Tetrarhynchus tetrabothrius, van Beneden (Pl. III., fig. 12).
(From the pike-dogfish.)

Five specimens of *Acanthias vulgaris*, the pike-dogfish, dissected at Piel by Mr. Scott, all had one or more specimens of a tetrarhynchid in the small intestines immediately behind the pylorus. These worms I am referring doubtfully to *Tetrarhynchus tetrabothrius*, van

* Bull. U. S. Fish Comm. for 1887, p. 731.

Beneden, although the specimens obtained do not agree very well with the description of this species. The worms were small. The strobila was very easily broken up, and in every specimen the most of the proglottides separated from each other immediately the specimen was placed in the preservative. Pl. V., fig. 12, which has been drawn from a preserved specimen, represents the head and neck of one of these specimens. There are four bothria lying very closely together. Each proboscis, when extended fully, is about twice the length of a bothrium. The neck is long and rather sharply marked off from the remainder of the strobila by a constriction. The first proglottides are very difficult to see, but are situated immediately behind this constriction. The largest proglottis was about 2 to 3 mm. in breadth, and 3 to 4 mm. in length.

The contractile bulbs are situated near the posterior extremity of the neck. Each is about twice as long as it is broad.

The hooks are arranged transversely, or in very imperfect spirals, on the proboscides. They have slightly backwardly-recurved points, and their bases are expanded. Each hook is in length about 0·013 mm.

The following are the principal measurements:—

Length of head	0·6 mm.
Breadth of head	0·9 mm.
Length of head and neck ...	2·75 mm.
Length of contractile bulbs ...	0·4 mm.
Breadth of contractile bulbs ...	0·22 mm.

T. tetrabothrius of van Beneden is recorded from *Mustelus* and *Acanthias*. At least one other Tetrarhynchid, *T. lingualis*, is also recorded from *Acanthias*, but the specimen described here is not this species.

* Faune littorale Belgique; Vers Cestoides. Nour Pleur. de l'Acad. Roy. de Belgique, T. XXV., 1850.

Tetrarhynchus erinaceus, van Beneden.
(From the Gurnard.)

About a dozen cysts containing larval Tetrarhynchi were found by Mr. H. C. Chadwick in the body cavity of a specimen of *Trigla hirundo*, dissected by him at the Port Erin Biological Station. The cysts were pear-shaped, and about 5mm. long, and of variable breadth. The broader ends were pearly-white in colour, and the narrower ends slightly yellowish. On dissecting these cysts each was seen to contain a Tetrarhynchid lying coiled up in the broader end. One contained also a trematode worm, but this latter was certainly an intruder. The tetrarhynchid is coiled up in a double S-shaped twist ƧS. If the two adjacent extremities of the letters are

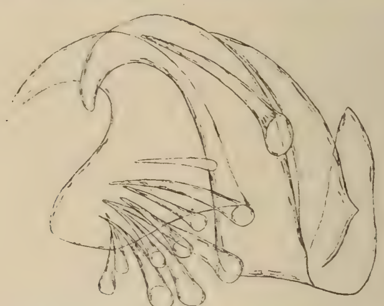


FIG. 7. A group of hooks from a proboscis of *Tetrarhynchus erinaceus*. × 1500 dia.

joined, and the paper is then folded, so that the letters lie side by side, the coils of the worm are represented. The worm, when straightened out, is about 4 to 5mm. in length. It is unsegmented, and possesses two moderately long bothria. The hooks of the proboscides are the most extraordinary features in the organisation of the animal. There are at least two different forms of these structures. Their appearance in the proboscis, when the latter is retracted, is shown in Text-fig. 7, and several isolated hooks are represented in the same figure. One kind of

hook, very large, is bent sharply round, about as far as an ordinary fish hook. Some of these large hooks have spurs on their proximal extremities. The other hooks are small, almost straight, and with slightly expanded bases. The contractile bulbs are long and narrow.

The larva bears a very strong resemblance to *Rhynchobothrium imparispine*, Linton*, a form described from *Raia erinacea*. But the latter worm is probably identical with, or is a variety of *Tetrarhynchus erinaceus*, van Beneden, a form described in the adult stage from *Raia* species, and as a larva from Gadoids and *Trigla*.

Acanthocephala.

Echinorhynchus acus, Rudolphi.

A small haddock, about 9 inches long, dissected during the fishermen's classes of 1904, yielded about 50 specimens of this acanthocephalan. The parasites were attached to the wall of the intestine immediately behind the pylorus. I am identifying them as *E. acus*, though they differ in some respects from the worm usually described as this form. They were of two lengths. The smaller were about 12mm. in length, and the largest about 30-35mm. There were few intermediate sizes. The proboscis was about 1mm. in length. The worms were lightly attached to the intestinal wall, and were easily detached. On killing in fresh water the proboscis was invariably protruded, and was nearly always slightly bent from the longitudinal axis of the body. Text-fig. 8 represents the tip of the proboscis. There are 12 to 13 longitudinal rows of hooks, which are not arranged transversely, but spirally, and each spiral contains 15 to 16

* Report U. S. A. Comm. Fish and Fisheries for 1887, 1891. p. 841, pl. xii., figs. 8 and 9.

hooks. The hooks are sharply bent backwards. Their proximal halves are thick, the distal halves slender and sharply pointed. Large and small worms present the same characters, so far as the proboscis is concerned. There is no distinct neck; sometimes a large bulla is formed immediately behind the proboscis, and occasionally a much smaller bulla may be formed at the extreme posterior end of the body.

FIG. 8. Tip of the proboscis of *Echinorhynchus acus.* × 80 dia.

PROTOZOA.

Lymphocystis johnstonei, Woodcock (Text-fig. 9 and Plate VI.).

Some time ago Mr. Scott sent me some specimens of flounders, which had been collected in the River Lune during the autumn of 1904, for the Piel Hatchery. A considerable number of the flounders from this area are infected with the sporozoan, described in the last Report from this Laboratory. Such infection is rare in the flounders from other parts of this district, although when in Luce Bay during November, 1904, four large fish of this species were obtained, and two of these were infected with the sporozoan in question. Some of the flounders from the Lune, however, had a tumour projecting from the ventral body margin immediately behind the anus, and at first sight this appeared to be caused by the terminal portion of the rectum being extruded, as sometimes is the case when the fish is badly squeezed in the trawl. Closer

examination showed, however, that the tumour was situated behind the anus, and had nothing to do with this opening. The tumours are not smooth, but appear to consist of a mass of small spherical bodies rather less than 1mm. in diameter, and lying closely in contact with each other. The skin covering the tumour is continuous with that covering the body, and is pigmented in very much the same way. Further examination showed, in fact, that the tumour was a mass of *Lymphocystis* individuals. In the same fishes there were other, but much smaller, tumours containing the same sporozoan. In another flounder, caught at the same time and in the same place, there was a large tumour projecting from the body wall on the blind side immediately over the anterior extremity of the ovary. This tumour was so very like a portion of the ovary that it was only by dissection and microscopical examination that one could be convinced that the body wall had not been ruptured in some way, and that the ovary had grown through the opening. The tumour was, however, connected to the body wall only by a pedicle of tough connective tissue containing blood vessels. Sections were made and stained, and it was then seen that it was *Lymphocystis* with which we had to do.

One of the specimens, with an anal tumour, was then dissected, and text-figure 9 represents the relation of the tumour to the surrounding structures. It lies quite clear from the anus, and between the latter and the beginning of the anal fin. On cutting it open its nucleus was seen to be formed by a stout bone projecting through the ventral body margin into the centre of the tumour.

This bone is the hypertrophied ventral extremity of the "anal spine." In all Pleuronectid fishes the posterior wall of the body cavity is bounded by a large and strong bone which curves round anteriorly from the roof of the

former, and terminates near the anus. This bone may be called the first axonost, but it is probable that it represents at least 3 separate axonosts fused together since it supports 3 baseosts. The anterior extremity of this bone is sharply pointed, and in dead specimens it almost invari-

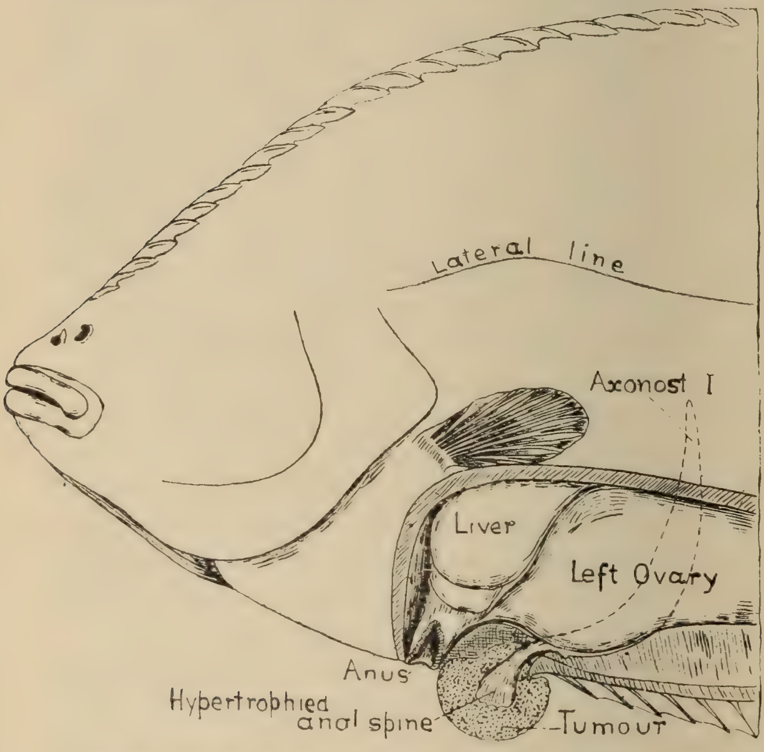


FIG. 9. *Pleuronectes flesus.* Dissection from the left side showing the anal spine and tumour. Natural size.

ably pierces the skin. A very slight amount of rough handling of the living fish causes the spine to start through the skin, and in some cases to inflict a nasty tear on the skin of the fingers or hand. But without this rough treatment the point of the spine never in life pierces the fish's skin.

The point of the axonost, even when it has pierced the skin, never projects through more than a millimetre or so. It is always very sharp. But the distal extremity of the spine shown in fig. 9 is greatly enlarged, and projects through the skin for some distance. Further, its end presents a peculiar appearance, as if it were made up of several spines fused together. The whole structure is, however, solid homogeneous bone. The point of the spine axonost has in some manner pierced the skin, and has then become greatly hypertrophied.

The point of the spine, in the normal fish, passes through dense connective tissue forming the ventral wall of the body cavity. In fish with hypertrophied anal spines, as in the above case, there is a distinct space between the spine itself and the surrounding connective tissue, and this space is filled up by the tissues of the tumour. These consist of a dense black ground tissue, not unlike a blood clot in process of resorption, and in this there are a great number of small, round bodies, which are the *Lymphocystis* individuals. The ground tissue consists of a mass of small cells, with large nuclei, and here and there it is infiltrated by large blood vessels. This tissue lies between the parasites and towards the centre of the tumour round the end of the spine. The parasites themselves present all the characters of *Lymphocystis*, as described by Woodcock, so that it is unnecessary to say anything about them here.

The whole structure, tumour and anal spine, is probably produced in the first instance by the laceration of the skin, caused by the accidental protrusion of the anal spine. The lesion thus caused is then invaded by the parasite, whether from within or without is uncertain. The hypertrophy of the anal spine itself is most probably the reaction to the parasite.

As a rule the degree of infection by *Lymphocystis* of flounders from the Lune is slight. But occasionally a specimen turns up in which the infection is very strong. Pl. VI. represents a fish which was forwarded to us a week or two ago by Mr. John Wright. In this case a large portion of the skin on both sides, but particularly of the ocular side, is covered with single and multiple *Lymphocystis* individuals. In this case emaciation of the fish was very marked.

Pearl-like Concretions in Fish Tissues.

In a gurnard (*Trigla hirundo*) dissected by Mr. Chadwick, at the Port Erin Biological Station, there occurred a number of small pearl-like bodies adhering to the layer of peritoneum covering the intestine. They were small, from 1 to 2 mm. in diameter, round or oval in shape. Their colour is reddish brown towards the centre, and light towards the margin, where the light is transmitted through the substance of the concretion. They were attached to the peritoneum by very delicate pedicles. They cut easily, and in meridional sections through the centre they present the general appearance of a decalcified pearl such as occurs in the mantle lobes of *Mytilus*. In no case examined were there any distinct signs of a nucleus possessing any obvious structure. The concretion is made up of a great number of concentric lamellæ, which seem to consist of wavy bundles of connective tissue, which stain a deep blue with Mann's methyl-blue staining fluid, in the same manner as ordinary connective tissues. Round this margin is a layer of different material, which has a slightly different staining reaction, and which seems to be continuous with the peritoneal strand which forms the pediels. Round the margin in this peripheral layer are small areas where there are small collections of densely-staining granules.

In one case one of these concretions was surrounded by a nematode coiled in two or three turns (fig. 10). In the centre round the concretion, between this and the worm, and between the coils of the worm itself, is a quantity of granular tissue. The whole structure is surrounded with a kind of capsule, evidently derived from the peritoneum, to which it is attached by a pedicle, as in the other cases.

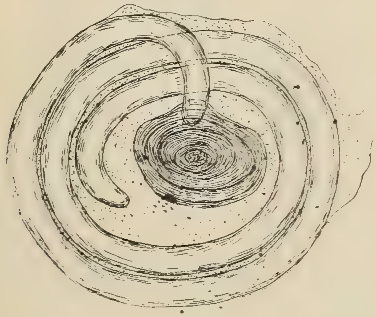


FIG. 10. Pearl-like concretion with nematode coiled round it. × 80 dia.

These structures are probably to be derived from the *Tetrarhynchus* cysts. In all cases the proximal ends of these cysts are pigmented and attached. If the enclosed larva should escape from the cysts, and the latter should undergo a kind of degeneration, the structure described would probably be formed. In one case the *Tetrarhynchus* cyst contained also a coiled nematode worm.

Flounders with Wounds Inflicted by Lampreys.

Flounders bearing wounds resulting from the bites of lampreys are not uncommon in the Lune, though we have not been able so far to get a fish with the lamprey still attached. A flounder with such a wound is represented in fig. 11. The wound was nearly circular and about 1½ mm. in diameter. It was clean and showed indications of healing, so that the lamprey had probably been detached for some time.

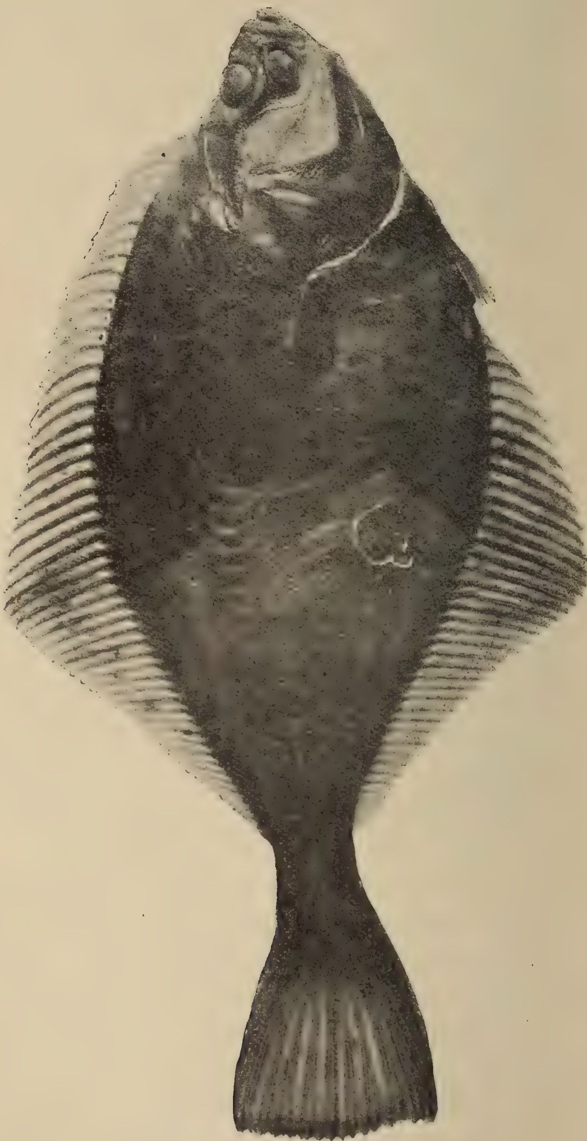


Fig. 11. Flounder, with wound made by lamprey. Reduced slightly.

Explanation of the Plates.

Plate III.

Fig. 1. Section of the anal fin of a plaice, made transversely to the long axis of the fish and showing cysts containing Trematode parasites. Mag. 50 dia.

Fig. 2. *Gasterostomum*, sp. Isolated from one of the cysts represented in fig. 1. Mag. 82 dia.

Fig. 3. *Gasterostomum*, sp. Anterior portion of the body, showing the dermal armature. Mag. 357 dia.

Fig. 4. *Gasterostomum*, sp. Section of the skin parallel to the long axis of the body, showing the spines.

Fig. 5. *Gasterostomum*, sp. Section of the skin, transverse to the long axis of the body showing the spines.

Fig. 6. *Gasterostomum*, sp. Oblique surface view of the spines.

Fig. 16. *Gasterostomum*, sp. Corpuscles from the interior of a cyst.

Figs. 4, 5, 6 and 16—Zeiss apo. 1·5 m. oil imm. lens.

Plate IV.

Fig. 7. *Gasterostomum gracilescens.* Specimen from the brain of the cod. Mag. 80 dia.

Fig. 8. *Gasterostomum gracilescens.* Encysted larva from the brain of *Phycis.* Mag. 80 dia.

Fig. 9. *Distomum valdeinflatum.* Larva still enclosed within the inner cyst. Mag. about 100 dia.

Fig. 10. *Distomum valdeinflatum.* Larva isolated from the cyst. Mag. 82 dia.

Fig. 11. *Gasterostomum gracilescens.* Part of the skin showing the dermal armature. Zeiss 1·5 mm. apo. oil immers.

Plate V.

Fig. 12. *Tetrarhynchus tetrabothrius.* Head and neck. Mag. 46 dia.

Fig. 13. *Cercaria fissicauda.* Cercaria isolated from *Cardium edule.* Magnified.

Fig. 14. *Distomum valdeinflatum.* Head, showing the armature of head and neck. Mag. 233 dia.

Fig. 15. *Distomum valdeinflatum.* Larva still enclosed in outer and inner cysts. Mag. 40 dia.

Plate VI.

"Lymphocystiasis." Flounder (*Pleuronectes flesus*) infected with the Sporozoan *Lymphocystis johnstonei,* Woodcock. Slightly reduced. Photograph by A. Scott.

Reference Letters.

Ant.sk. = Anterior sucker.
Cy. = Cyst wall.
Cy.Ext. = External cyst.
Cy.Int. = Internal cyst.
Cir. = Cirrus.
Con.b. = Contractile bulb.
Int. = Intestine.
Or.sk. = Oral sucker.
Ov. = Ovary.
Ph. = Pharynx.
Pb. = Proboscis.
Pb.sh. = Proboscis sheath.
Par. = Parasite.
Sp. = Spine.
Te. = Testis.
Ut. = Uterus.
Vit. = Vitellarium.
Vit.Dt. = Duct of the vitellarium.
V.sk. = Ventral sucker.

Fig. 1.

Fig. 4.

Fig. 5.

Fig. 6.

Fig. 2.

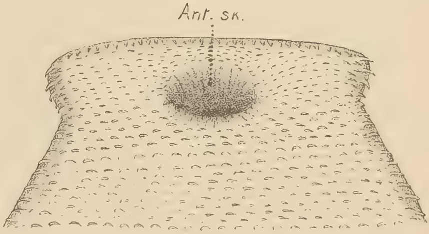


Fig. 3.

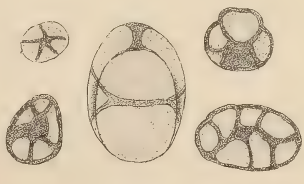


Fig. 16.

J. J. del.

S. B. lith.

GASTEROSTOMUM, sp.

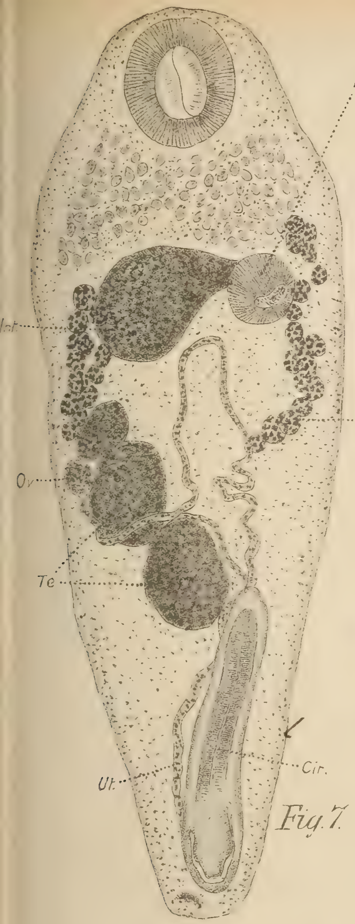


Fig. 7.

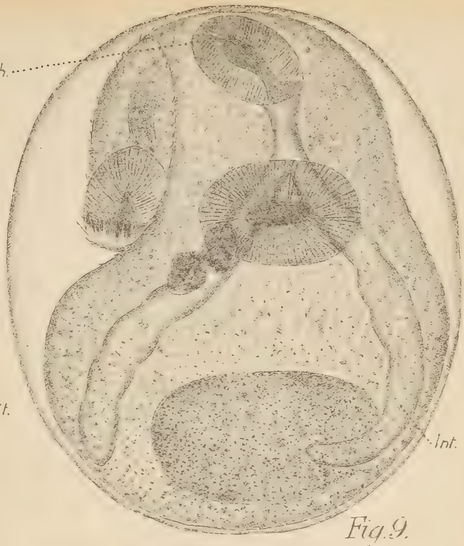


Fig. 9.

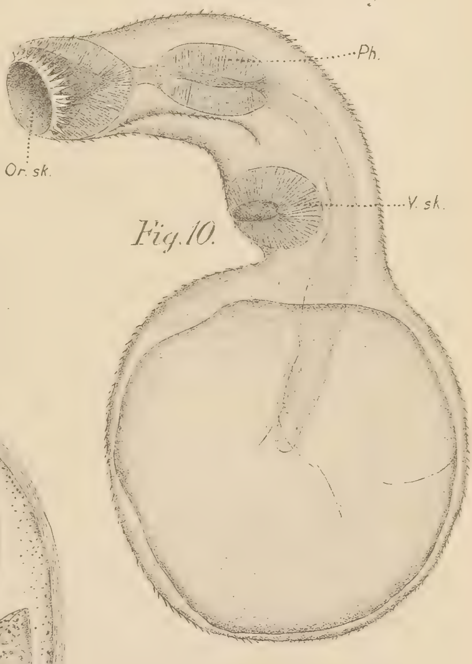


Fig. 10.

Fig. 8.

Fig. 11.

J. J. del.

S. B. lith.

FIGS. 7, 8, 11. GASTEROSTOMUM GRACILESCENS.

FIGS. 9, 10. DISTOMUM VALDEINFLATUM.

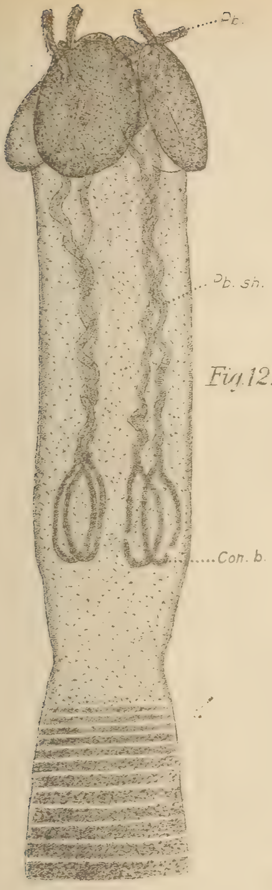
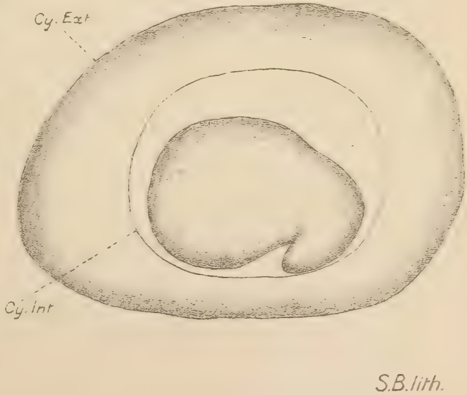


Fig. 12.

Fig. 13.

Fig. 14

Fig. 15.



A.S. del. 13.
J.J. others.

S.B. lith.

FIG. 12. TETRARHYNCHUS TETRABOTHRIUS.

FIG. 13. CERCARIA FISSICAUDA.

FIGS. 14 & 15. DISTOMUM VALDEINFLATUM.

Plate VI.

Flounder (*Pleuronectes flesus*), with the Sporozoan, *Lymphocystis johnstonei*, Woodcock.

FLOUNDERS WITH SPINULATED SCALES.

By Jas. Johnstone.

While trawling in Luce Bay during November, 1904, several unusually large flounders (*Pleuronectes flesus*), 14 to 16½ inches in length, were captured, and on handling these it was seen that all were scaled in an abnormal manner, the greater part of the head being covered with spinulated scales. Flounders on the N.W. Coast of England do not present this peculiarity to a noteworthy extent, but it is nearly always the case that there are single rows of spinulated scales along the bases of the dorsal and anal fins, and that several rows of these structures are to be found at the beginning of the lateral line on both ocular and blind sides, but principally on the former. These peculiar scales are not generally very obvious in our English flounders,* but are much more common in fish from the Scandinavian Coasts.

The fish referred to here (See fig. 11) is a male, 15 inches in total length. It was unusually darkly pigmented. There were 62 rays in the dorsal, and 44 in the anal fin. Along the bases of both dorsal and anal fins on the ocular side are rows of spinulated scales, but these are much less in number than the adjacent fin rays. The greater part of the head on the ocular side bears these scales, and there are patches round the insertion of the pectoral fins and on the skin in front of the insertions of the pelvics. The greatest development of these structures is along the lateral line of the ocular side. At the beginning of the latter are several rows of spinulated

* See Holt, M. B. A. Journ., Vol. 3, p. 197, 1893—5.

scales, and two rows at least persist as far back as about two-thirds of the length of the fish. After that they become less frequent, and disappear. On the blind side there are a few scales along the bases of both dorsal and

FIG. 12. FLOUNDER, with spinous scales on head, &c. (reduced). A separate scale is also represented, mag. about 6 dia.

anal fins, and some round the insertion of the pectoral fins, but they are much fewer in number than on the ocular side.

The largest of these spinulated scales are found along the lateral line; they are about 3 mm. in diameter—a single scale is represented in fig. 11. On the anterior margin is a depression, and from this, as a centre, are several radiating rows of spines. The scale is very thick; ground sections shew that it is composed of dense bone without obvious vascular channels, but with lacunæ and canaliculæ. Between the rows of spines it is covered with a thin pigmented epidermis.

EXPERIMENTS ON LOBSTER REARING.

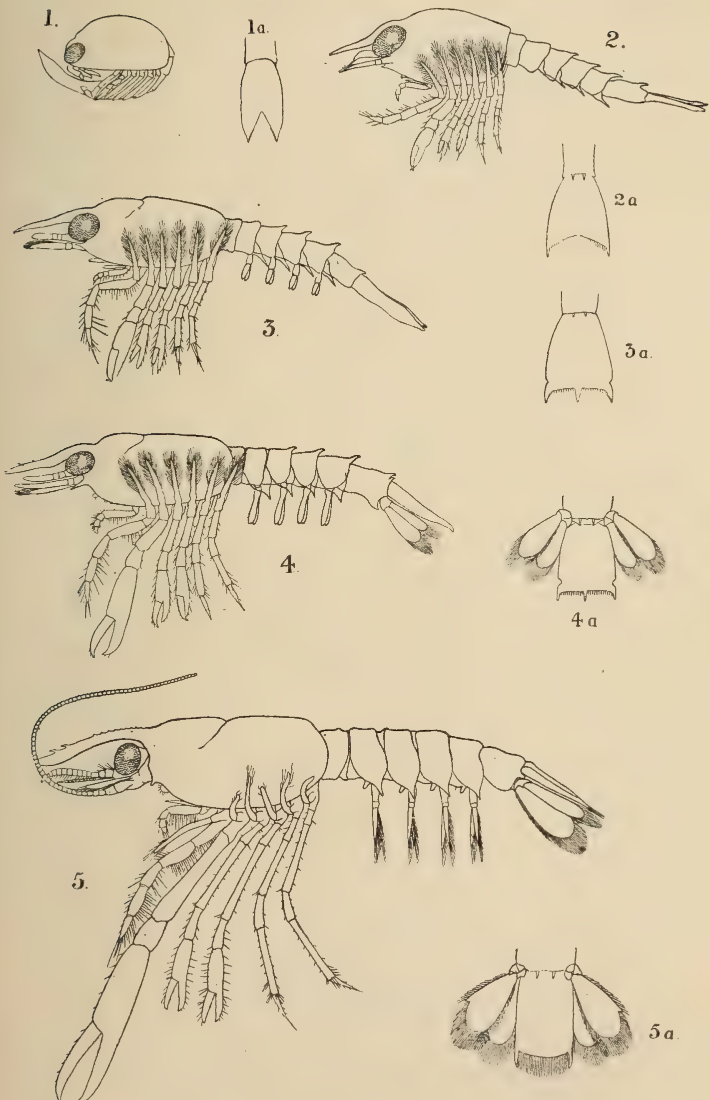
By H. C. Chadwick.

The following notes and accompanying figures are based upon experiments in hatching and rearing larvæ of the common lobster, conducted in the fish hatchery at Port Erin during the months of July and August, 1904.

Female lobsters, carrying nearly ripe eggs, were obtained at the latter end of June and the beginning of July, and were kept in the compartments of the hatching tanks, excepting those at the ends of the tanks, in each of which a "Dannevig" box was fixed. The first larvæ were hatched during the early hours of the morning of July 15th, and were carried by the current of water running through the tanks into the boxes at the lower ends, from whence they were transferred by means of a pipette to the boxes at the upper ends. Short lengths of rubber tubing carried the stream of water from the taps directly into the boxes, thus ensuring abundant aeration and a fairly rapid whirling motion of the whole body of water in the box.

From the above-named date onwards for several weeks from 100 to 400 larvæ were hatched during every night until the number reached 5,000. They were fed daily upon the finely minced liver of the shore crab, *Carcinus mœnas,* and the edible crab, *Cancer pagurus,* and for a time appeared to thrive upon it, but at the time of the ecdyses or shell castings many died, and comparatively few reached the "lobsterling" stage

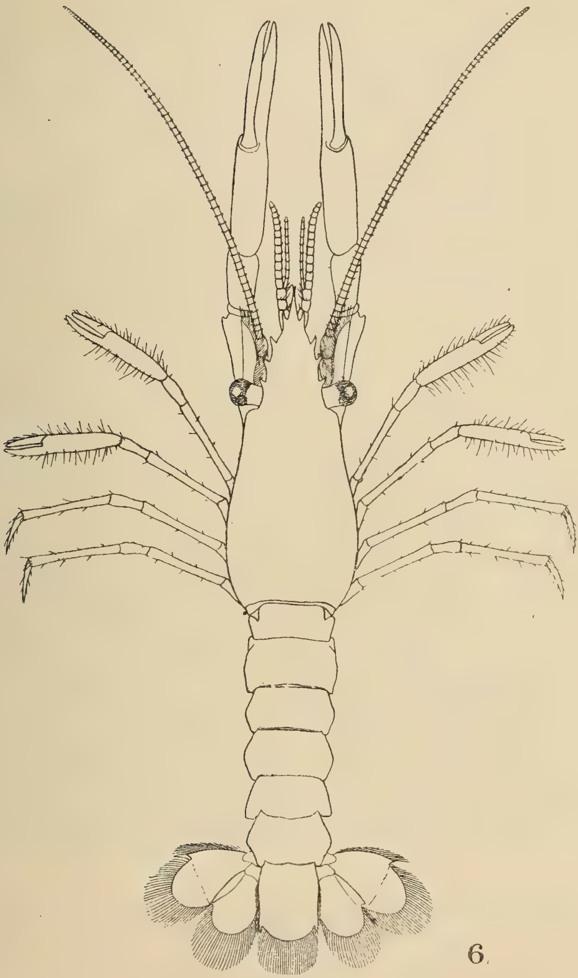
Immediately after the rupture of the egg-shell, the young lobster (fig. 1) is seen with the abdomen, or "tail" as it is commonly called, closely applied to the ventral face of the thorax, and the thoracic appendages folded in



Development of Lobster.—1, larva immediately after hatching; 2, one day old; 3, after first ecdysis; 4, after second ecdysis; 5, after third ecdysis. 1*a*, 2*a*, 3*a*, 4*a*, 5*a*, tail seen from above at corresponding stages. All mag. 5 dia.

regular order upon it. The posterior edge of the telson (fig. 1a) at this stage is rather deeply cleft. The abdomen is at once extended, the exopodites of the third pair of maxillipedes and of the five pairs of walking legs assume their function as swimming organs, and the tiny animal begins its free swimming life in what is known as the *Mysis* stage (fig. 2). The carapace has a simple frontal rostrum and a minute lateral spine on either side, close to the compound eye. The third to the sixth segments inclusive of the abdomen have dorsal and lateral spines, and there is a single minute median spine on the posterior edge of the telson (fig. 2a), which is now much less deeply cleft and fringed with setæ. The first antennæ are unjointed, the second are biramose. The penultimate and terminal joints of the three anterior pairs of walking legs form pincer-like organs, as in the adult. Thus constituted, the larva swims actively, with the plumose exopodites of the walking legs and third maxillipedes projecting laterally like oars, and the abdomen rather strongly flexed beneath the thorax. This stage persists until about the seventh day, when the first ecdysis takes place, and several new features in the structure of the larva appear (fig. 3). The second, third, fourth and fifth segments of the abdomen now bear rudimentary swimmerets. The principal flagella of the first antennæ are segmented and rudimentary accessory flagella appear. Little change is noticeable in the telson (fig. 3a).

A second ecdysis occurs about the fourteenth day, and introduces the third larval stage, which presents additional structural features of importance (fig. 4). The first pair of walking legs are now proportionately larger than their successors, and foreshadow the great chelæ of the adult. The abdominal swimmerets are more conspicuous, and the appendages of the sixth abdominal


6.

YOUNG LOBSTER, or "LOBSTERLING," after the fourth ecdysis. Mag. 5 dia.

segments appear for the first time (fig. 4a). The dorsal and lateral spines of the abdominal segments are less prominent, while two small ones appear on the rostrum.

A third ecdysis occurs about the beginning of the fourth week, and brings about still further changes (fig. 5). The flagella of the second antennæ are now long and many jointed, and resemble those of the adult. The plumose exopodites, no longer needed as swimming organs, have almost completely lost the setæ with which they were fringed in their functional condition, and are much reduced. The dorsal median line of the rostrum is serrated, and the two spines on its front are well marked. The abdominal swimmerets are fringed with setæ, and are used in swimming; the telson (fig. 5a) has lost the median spine on its now slightly convex posterior edge, and a strong tooth appears on the outer edge of the exopodites of the sixth abdominal segment.

A fourth ecdysis occurs early in the fifth week, and while the larva (fig. 6) still swims actively, it spends much time on the bottom and quickly appropriates any convenient hiding place. The chelæ are almost invariably rigidly extended in front when the animal swims. After further ecdyses they become asymmetrical, as in the adult, and the appendages of the first abdominal segment are developed. The latter are at first of similar form in the two sexes, but acquire sexual characters at a later stage.

APPENDIX.

DISCUSSION OF OFFICIAL FISHERY STATISTICS

By J. Travis Jenkins, D.Sc.,

Superintendent of the Lancashire and Western Sea Fisheries District.

From time to time quotations have appeared in former quarterly reports as to the weight and value of fish landed in the Lancashire and Western Sea Fisheries District, these figures being based on the monthly returns furnished by the Board of Agriculture and Fisheries (formerly by the Board of Trade).

The question of the efficacy of the protection to the fisheries of the district afforded by the bye-laws of the Joint Committee, obviously can only be solved by reference to carefully compiled statistics, and, with a view of drawing attention to the question of fishery statistics, I have gone into the whole of the statistical information available at present, and a brief résumé of the results of this inquiry is appended. At the outset it must be clearly understood that the results here given are taken from the figures furnished monthly by the Central Authority, and that no other official statistics of any kind are available. It is a matter for regret that more detailed information is not available, because, as will be explained below, except in a few instances the figures throw but little light on the fish actually caught in or near the district under the jurisdiction of the Joint Committee.

The Central Authority furnish three distinct returns :—

(1) The title of the last available paper is quoted :— A "copy of statistical tables and memorandum relating to the Sea Fisheries of the United Kingdom in the year 1902 ; including also a return showing the quantity of fish carried by railway from each of the principal ports of *England* and *Wales*, *Scotland* and *Ireland*, in each year, from 1897 to 1902 inclusive."

This is a return printed by the order of the House of Commons. This return gives each year the total quantity (excluding shell-fish); the total value (excluding shell-fish) and the total value (including shell-fish) for each port in the Lancashire and Western Sea Fisheries District, at which statistics are taken.

(2) A printed statement headed "Board of Agriculture and Fisheries. Fishery Statistics—England and Wales." Statement showing the quantity and value of fish landed on the English and Welsh coasts during the month of (say) April, 1904, with comparative statement for 1903, distinguishing the East, South, and West coasts respectively.

(3) A monthly summary of the returns of fish landed from the Fishing grounds at the ports in the district. The figures are written in a printed form. This is the form which gives the most detailed information, and to which reference is most frequently made below.

Report (1) is an annual one; (2) and (3) are monthly returns.

The tables actually published in the present Report only represent a very small fraction of the figures actually dealt with.

The statistical reports of the Board of Agriculture and Fisheries (formerly reports of Board of Trade) have been severely criticised by various writers, notably by the naturalists on the staff of the Marine Biological Association.*

From the point of view of the Joint Committee there are several difficulties which, however, can hardly be attributed to the Central Authority. The first difficulty arises from the fact that various changes have been made from time to time

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* Report on Fishery Statistics, prepared for the Council by the naturalists on the staff of the Marine Biological Association of the United Kingdom, June, 1896. (This criticism applies to Board of Trade returns only.)

in the size of the district, and Reports are only supplied giving the weight and value of fish landed at fishing ports within the district. Consequently, while we have the monthly statistics for some ports, Fleetwood and Southport for example, for over 10 years; for other ports, Holyhead and Carnarvon for example, we have monthly figures for five years only. From March, 1894, to the end of 1899, monthly returns are to hand giving the weight and value of wet and shell fish landed at the ports of Rhyl, Hoylake, Liverpool, Southport, Lytham, Fleetwood, and Morecambe.

At these ports Board of Trade collectors were engaged in collecting statistics relating to the weight and value of fish landed. The value of the fish to the consumer is certainly far in excess of the figures given. Statistics of fish landed at ports or places such as Barrow District, not included in the above list, are not available, so that the figures given may safely be regarded as minimal values for the whole district.

It will be noted that the above list of ports are those in the Lancashire Sea Fisheries District as varied by an order made by the Board of Trade in 1894 under the provisions of the Sea Fisheries Regulation Act of 1888. These monthly Reports deal with both "wet" fish (including brill, cod, hake, haddock, halibut, herrings, ling, mackerel, pilchards, plaice, soles, sprats, turbot, and "all other except shell-fish"); and with crabs, lobsters, oysters, and "other shell-fish." As a rule, "other shell-fish" include cockles, mussels, whelks, and shrimps under separate headings. In April and May, 1896, we have the heading "Kewins," which I understand is the local name for periwinkles. During the years 1895 to 1899 separate monthly returns of weight and value are given for each of the above-mentioned fish. A minor point which adds considerably to the difficulty of manipulating these figures is that the forms vary, sometimes the weight and value are given in different tables, sometimes in the same table.

Nearly all totals given in the following pages have had to be calculated, and the task has been a very laborious one, owing to the way the returns are made up. After two or three days calculation a variation in the manner the return is made up has vitiated the result, and the whole series of calculations has had to be commenced over again.

For this period (1895-1899) no statistics from the former Western District are available, consequently for all calculations based on a decennial period the Western District has had to be omitted, and returns made for the Lancashire area only (as varied by the Order of the Board of Trade in 1894). It is thought that a comparison of annual figures should be based on at least a decennial period in order to avoid fluctuations due to extraneous influences, such as the weather. It is to be regretted that the Western District returns have been lost. From 1900 to the present time returns are to hand for the following ports in addition to those of the old Lancashire district (1894-1899):—New Quay (Cardigan), Aberayron and Aberystwyth, Borth and Aberdovey, Pwllheli, Carnarvon, Holyhead, Bangor, and on the same sheet and in juxtaposition Cark and Ulverston!

For a time the returns from the Western District (including Cark and Ulverston) are made on a separate sheet; *i.e.*, the old Lancashire area is kept intact, and consequently there is little difficulty in abstracting the figures for comparison with the years 1894-1899. An innovation is seen in the case of Cark and Ulverston; "cockles," we are now told, include mussels and periwinkles. This renders both "cockle" and "mussel" figures for separate comparison useless for the whole district, at any rate until further information be obtained, if, indeed, it is at all attainable now.

The cockle statistics will be discussed in greater detail later; it will perhaps suffice to here refer to a paper by Mr. Johnstone in the Lancashire Sea Fisheries Laboratory Report

for 1899, in which cockle statistics are dealt with (pages 97 to 110). In the case of Fleetwood and Liverpool shrimps sometimes include prawns. These prawns, however, are quite different to the Western District prawn. The Fleetwood and Liverpool prawns are *Pandalus annulicornis*. The common shrimp is *Crangon vulgaris*. These are included together in the following tables. The Western District prawn is *Palaemon serratus* and is not included. In June, 1900, there is another variation in the arrangement of the tables; all the ports are now grouped together on one sheet, Cark and Ulverston being removed from the Western District, and placed *between* Fleetwood and Morecambe! In 1900 "other shell-fish" are treated in four columns, as (1) cockles (including mussels and periwinkles for Cark and Ulverston but not for other ports), (2) mussels, (4) shrimps, the third column being sometimes whelks, sometimes periwinkles, and sometimes prawns. During 1901 there are no whelks and no periwinkles, except the periwinkles included as cockles for Cark and Ulverston, the third column being always prawns, except during December, when "whelks" is again the heading. In January, 1902, "other" shell-fish are grouped in six separate columns, periwinkles, prawns, and whelks now being treated to a separate heading. In 1902 "wet" fish are also treated in greater detail, and the order of the columns again varied, this, of course, still further increasing the difficulty of extraction. In addition to the wet fish enumerated separately from 1894 to 1899 (*vide* above) the following fish now appear under distinctive headings, viz.:—conger eels, dabs, gurnards, lemon soles, skates and rays, whiting.

From 1902 to the present year there is little change; but, in January, 1903, further groups of wet fish are treated to separate headings, viz.:—sparling, catfish, megrims, monks (or anglers), torsk, and witches. In April, 1904. the final change is made. Cod, we are now informed, include codling; and the monthly summary undergoes a complete alteration

in form, the quantities and values being now placed in juxtaposition instead of being as before in separate tables. Sparling are now omitted, and "all other" wet fish include salmon. According to the Central Authority returns, it appears that, during the fifteen months sparling statistics were collected, sparling were only once landed in the Lancashire and Western Sea Fisheries District, namely, 2 cwts. in Liverpool, in July, 1903.

It is not intended that the above remarks should in any way reflect on the Central Authority, who have had to deal with a difficult problem with inadequate financial aid; the notes are made simply with a view of pointing out the difficulties of selecting suitable material for presentation in a report of this kind.

A second difficulty in dealing with the Lancashire and Western Sea Fisheries area, and to the present writer a far more important one than the first, is that the fish landed at the above-mentioned ports do not represent the fish caught within or even adjacent to the area under the Committee's jurisdiction. The steam trawlers which land their catches at Fleetwood and Liverpool go as far as the S.W. Coast of Ireland or even to the Bay of Biscay, and there is no attempt made in the returns to discriminate between such fish and fish captured within the Irish Sea area, much less within the three mile limit.

In addition to the above there have been, at various times, foreign steam trawlers fishing in the Firth of Clyde in an area closed to British steam trawling. The fish caught by some of these trawlers in the Firth of Clyde is landed at Fleetwood and is included in the returns sent by the Central Authority.

Of course these returns only affect certain classes of fish, but until some discrimination is made between fish caught within the Irish Sea area and fish caught outside, the reports of the Central Authority will have no value for our purpose.

Other classes of fish, notably shrimps, are not affected by this criticism and can be and are discussed below. It is of the utmost importance that some attempt should be made at the earliest possible opportunity to discriminate between fish caught within the Irish Sea area and fish from the Bay of Biscay, Firth of Clyde, and S.W. Coast of Ireland. It is to be hoped that some scheme may be devised for obtaining information from the masters of fishing vessels of all classes as to the quantity of fish captured, and where (within reasonable limits) such fish have been captured. Until this, or some alternative scheme to that in use at present, is done no satisfactory or reliable statistical information can be looked for.

The subject is one of sufficient importance to justify the appointment of a Sub-Committee to consider the possibility of devising some scheme for the collection of reliable statistics for this District. This Sub-Committee, if appointed, could enter into the question of the best means of obtaining reliable information at the minimum cost, and several methods of acquiring information readily suggest themselves. The question of acquiring information direct from the masters of fishing vessels might be considered, and its relative advantages and disadvantages compared with the method of employing collectors or utilising the services of the bailiffs to supplement the Board of Trade returns. Failing statutory powers to compel the masters of vessels to make returns of the quantity of fish landed and the location of the fishing grounds, one would be compelled to devise some system of payment to the skippers for, say, monthly returns.

Such a scheme would probably prove costly, and if any appreciable proportion of masters failed to make returns, or rendered obviously inaccurate or misleading reports, then the whole system would be vitiated.

If such a scheme were considered, an estimate of the approximate number of the boats registered from each of the

fishing ports would be serviceable, and such an estimate extending over a series of 11 years is appended below. It should be noted that the number of boats registered at a given port and the number landing fish at that port may not coincide. But for the whole district, with the exception of steam trawlers, the number of boats registered would, approximately, represent the number landing fish. Assuming, for the purpose of argument, that it is advisable to remunerate masters of fishing vessels for monthly returns, it then becomes necessary to consider the amount of reward payable to each class of boat.

Table showing number of Boats belonging to Fishing Ports in Lancashire and Western Sea Fisheries District, from 1892 to 1902:—

Year.	Steam Trawlers.	Sailing Trawlers. 1st Class.	2nd Class Boats.	3rd Class Boats	Number unregistered
1892	8	118	487	220	n. r.
1893	7	121	504	213	n. r.
1894	9	116	515	205	n. r.
1895	24	100	507	213	n. r.
1896	29	102	514	214	n. r.
1897	46	97	503	221	n. r.
1898	48	93	505	202	241
1899	18	96	459	198	247
1900	19	95	422	214	236
1901	20	99	413	209	235
1902	23	105	391	203	255

The above table takes no account of vessels belonging to other ports which land fish at ports within the district. n. r. means no return.

The figures are collated from the annual reports of the Fishery Inspectors.

Table showing approximate number of Steam Trawlers landing fish at Fleetwood and Liverpool, 1890—1902 :—

	1890	1891	1892	1893	1894	1895	1896	1897	1898	1899	1900	1901	1902
Fleetwood.	...	...	11	11	10	21	19	36	40	8	25	39	21
Liverpool..	5	7	13	12	18	18	17	20	22	22	17	16	20

Another method of procedure would be for the bailiffs to collect information. At present the bailiffs send in quarterly reports giving the average catches per tide or per voyage (for all kinds of fishing) as the case may be, and also the average price. A slight addition giving the average number of men or boats fishing would enable calculations to be made which would be interesting for comparison with the Central Authority's figures. This addition to the present quarterly return would not ensure much additional labour to the bailiffs. A table showing the approximate number of boats and hands in each bailiff's division is given below. It is interesting to compare this table with the table issued by the Central Authority showing the number of boats registered at ports within the area.

Table (prepared in July, 1903) showing the approximate numbers of boats and hands employed in the Lancashire and Western Sea Fisheries District :—

	Nos. of Boats.	Nos. of Men.	Totals. Boats.	Totals. Men.
Fleetwood Division—				
1st Class Sailing Boats	48	240		
2nd ,, ,, ,, ...	143	238		
3rd ,, ,, ,, ...	4	4		
3rd (a) ,, ,, ,, ...	139	179		

	Nos. of Boats.	Nos. of Men.	Total. Boats.	Total. Men.
Steam Trawlers	32	288		
Shore Fishermen...	...	329	366	1278
New Brighton Division—				
1st Class Sailing Boats	45	186		
2nd ,, ,, ,, ...	148	296		
3rd ,, ,, ,, ...	30	36		
3rd (a),, ,, ,, ...	36	36		
Steam Trawlers	17	136		
Shore Fishermen	...	*254	276	944
Carnarvon Division—				
1st Class Sailing Boats	7	28		
2nd ,, ,, ,, ...	28	61		
3rd ,, ,, ,, ...	...	...		
3rd (a) ,, ,, ,, ...	†241	241		
Steam Trawlers	1	4		
Shore Fishermen...	...	‡68	277	402
Pwllheli Division—				
1st Class Sailing Boats	8	24		
2nd ,, ,, ,, ...	20	43		
3rd ,, ,, ,, ...	23	46		
3rd (a) ,, ,, ,, ...	75	222		
Steam Trawlers	...	...		
Shore Fishermen...	...	133	126	468

	Nos. of Boats.	Nos. of Men.	Total. Boats.	Total. Men.
ABERDOVEY DIVISION—				
1st Class Sailing Boats	6	23		
2nd " " "	25	97		
3rd " " "	3	6		
3rd (a) " " "	40	40		
Steam Trawlers	...	...		
Shore Fishermen...	...	140	74	306
NEW QUAY DIVISION—				
1st Class Sailing Boats	2	7		
2nd " " "	4	9		
3rd " " "	13	26		
3rd (a) " " " ... --	49	147		
Steam Trawlers	...	...		
Shore Fishermen	...	137	68	326
			1187	3724

* Men and women.
† This number is apparently exaggerated.—J.T.J.
‡ Mostly women.

The Fleetwood division extends from Haverigg Point (northern limit of District) to the Nelson Buoy in the Ribble estuary. The New Brighton division extends from Nelson Buoy to Rhos Point, in Denbighshire. The Carnarvon division extends from Rhos Point to Nevin. The Pwllheli division extends from Nevin to Barmouth. The Aberdovey division from Barmouth to Aberystwyth, and the New Quay division from Aberystwyth to Cemmaes Head (southern extremity of District).

1st Class Boats.—15 tons and over.

2nd Class Boats.—Under 15 tons register, but with sufficient deck and cabin accommodation for the crew to live on board.

3rd Class Boats.—Under 15 tons register and partly decked, but *not* sufficiently for the crew to live on board.

3rd (a) Class Boats.—Small open boats propelled by sails or oars.

It would, at any rate, be interesting to collect statistics for, say, three years in some manner and then compare the figures with those furnished by the Central Authority. Even should the above or some similar scheme be found impracticable on account of the expense and extra labour involved, it ought to be a fairly easy matter to collect returns of fish caught outside the Irish Sea area (an area to be defined) and which are landed at ports in the district.

Probably this might be feasible provided the co-operation of the owners of the steam trawlers was obtained, and it would probably be found more suitable from the Committee's point of view than the attempt to collect returns on a much larger scale—returns which could not attain to completeness on account of Manx and Brixham boats fishing within the Irish Sea area and landing their fish outside the district. It will be noticed that the term Irish Sea area is often used in preference to the territorial waters; since, although the Committee have no jurisdiction over the Irish Sea as a whole, the fish caught there may frequent the inshore waters at some stage of their life history, and consequently may be potentially protected by the Committee's bye-laws.

We come now to the question of the figures already in our possession. Can they be reasonably utilised to furnish any record of the Irish Sea fisheries as a whole? When one considers what we have and what we might have had there is but one feeling—that of regret.

In the first place, we have figures showing the total annual value of fish (wet and shell) landed at each port in the Lancashire and Western Sea Fisheries district for 16 years, and these figures show on the whole a steady increase.

No conclusion as to the Irish Sea area as a whole can be deduced from a study of these figures, since even if one eliminates the steam trawler ports entirely—Fleetwood and Liverpool—one eliminates a large quantity of fish caught in the Irish Sea, not only by the steam trawlers themselves, but also by the various sailing craft, which get their fish almost entirely within the Irish Sea area.

If one only had a reliable idea as to the quantity of what I may call foreign fish—Bay of Biscay, South-West Ireland, and Firth of Clyde fish—to deduct from these figures it would give one some idea—probably accurate in an approximate manner (and strive as we will our estimates must always be approximations)—of the increase or decrease of the yield of the Irish Sea fisheries. As pointed out above, this should not be impossible in the future, though even then our estimate would be based on the assumption that the Central Authority's figures are accurate, for it is hardly necessary to point out that to deduct an accurate total from an inaccurate one will not give an accurate remainder.

The question of accuracy is, of course, a vital one; it is hardly necessary to point out that inaccurate tables are worse than none at all. The arrangement of the tables is quite a minor point as compared with accuracy, and as will be seen from the facts detailed below, when comparison is possible, the results are scarcely satisfactory.

For instance, the statistical tables and memorandum relating to the Sea Fisheries of the United Kingdom for the year 1890 (published by the Board of Trade, 4th March,

1891) give on page 21 the total value of wet and shell fish landed at Southport and Marshside during 1890 as £4,097. In the Report of the evidence taken at the inquiries held by the Sea Fisheries Committee of the County Council of Lancashire at Southport and other places (published by Parkinson, Preston, 1890), we find that on the 22nd November, 1889, the Town Clerk of Southport (Mr. Ellis), in his evidence stated that he estimated the value of fish landed at Southport, Banks, and Marshside at £16,000 a year (see page 25 of the Report). His calculation was based on returns from the Railway Company of what is sent to the various inland towns, and an estimate of what is got by hawkers. In 1890 the Board of Trade commenced making returns from Southport and Marshside, and in round numbers their estimate is *one-fourth* of the estimate of an independent person who, at any rate, must have been in as good a position as the Board of Trade collector to form an estimate. As another example, the district which extends from Aberayron to the south side of the Mawddach estuary (below Barmouth) is represented in the Central Authority's return by two pairs of ports grouped together, viz.:—Aberayron and Aberystwyth, Borth and Aberdovey.

Mr. Davies, our bailiff at Aberdovey, has made careful estimates for three years of all fish landed between Aberayron and the south side of the Mawddach, and his figures are here compared with those of the Central Authority for the same district:—

	Mr. Davies's Return (Aberayron to Llwyngwril).	Central Authority (Aberayron to Aberdovey).
	£	£
1902...	3422	1830
1903...	2577	1821
1904...	3427	2507

To set out the results for 1904 in greater detail we find—

Place	Mr. Davies's Return.	£	Central Authority.		£
Aberayron, Llanon, and Llanrhystyd..	Periwinkles...	70...	Aberayron and Aberystwyth	Wet fish ..	2353
				Mussels...	6
				Prawns ...	6
Aberystwyth	...Wet fish ...	2612...	No mention of Llanon and Llanrhystyd		
	Prawns ...	30			
	Crabs and Lobsters ...	20			
	Total	...£2732	Total		£2365
Borth ...	...Wet fish ...	40...	Borth and Aberdovey...	Wet fish ..	142
	Crabs and Lobsters ...	10		Shell-fish.	—
	Shrimps and Prawns ...	50			
Treddol and Ynyslas Cockle Beds	...Cockles ...	140...	No return		
Aberdovey...	...Wet fish and Mussels ...	310...	—		
Towyn ...	...Wet fish ...	50...	No return		
Tonfanau ...	...Bass, Crabs, Lobsters, Prawns ...	40...	No return		
Llwyngwril	...Crabs and Lobsters ...	25...	No return		
	Prawns ...	30			
Total for whole district		...£3427			£2507

One curious result is noticeable on detailed examination. At Aberystwyth (including Aberayron) we have shell-fish landed during one month only in the years 1902, 1903, and 1904, except £6 worth of prawns in July, 1904, according to the Central Authority's Returns, and this shell-fish consisted of mussels landed in January, the weight being 1902, 96 cwts.; 1903, 191 cwts.; 1904, 40 cwts. The nearest mussel beds to Aberystwyth are in the Dovey river. In 1900 and 1901 there were no shell-fish of any kind landed at Aberystwyth (including Aberayron). Yet during 1901 the Joint Committee obtained convictions in four cases of taking undersized crabs at Aberystwyth. It is to be presumed that where fishing for crabs goes on a certain amount of full-sized specimens are landed. Mr. Davies gives £20 for Aberystwyth for 1904 for crabs and lobsters, as against nil for the Central Authority. Mr. Davies further states that every year 200 to 250 bags of periwinkles are sent away from Aberayron and Llanon. No note is made of this in the Central Authority's return. It is to be noted that no collection of statistics is attempted by the Central Authority at Llanon, Llanrhystyd, Ynyslas, Towyn, Tonfanau, and Llwyngwril, yet, according to Mr. Davies, the estimated value of fish landed at these places for 1904 is £365, including Aberayron periwinkles, which are also omitted in the Central Authority's returns. I have myself, during 1904, seen cockles landed from the beds in the Dovey at Aberdovey. There is no mention of these in the Central Authority's returns.

Another example is afforded by Pwllheli. Here, be it noted, there is a remarkable diminution from £20,444 in 1898 to £7,169 in 1903. So marked is the diminution that it becomes necessary to look into the figures a little more closely, when some exceedingly interesting results are noticeable. Unfortunately the monthly returns for the Western District previous to the amalgamation are unobtainable, so we may commence with the year 1900.

The Board of Trade Returns for Pwllheli for 1900 give figures for cod, hake, and ling as follows :—

PWLLHELI, 1900.

	Cod.	Hake.	Ling.
January	47	12	10
February......	56	17	10
March	68	21	14
April	69	21	14
May	87	27	20
June...........	86	35	20
July	84	77	26
August.........	90	37	22
September ...	74	28	14
October	75	31	20
November ...	96	34	24
December ...	44	19	12

These kind of fish were worth exactly £1 per cwt. during the whole year.

On referring to the figures for 1904, we find no hake, no ling, and but 3 cwt. of cod, value £6, were landed at Pwllheli.

Can this be a truly remarkable example of over fishing, or can it be that the railway rates have caused the trawlers to land their fish elsewhere, or can it be—I hesitate to suggest the alternative—that the hake, cod, and ling of 1900 existed only in the Board of Trade collector's imagination ?

Perhaps some light may be thrown on the subject by tracing the progress of this phenomenal diminution. Was the falling off gradual or sudden, and, if sudden, did it coincide with the appointment of a new Board of Trade collector at Pwllheli ?

PWLLHELI, 1901.

	Cod.		Hake.		Ling.
January	59	...	16	...	13
February	55	...	20	...	23
March	94	...	37	...	28
April	82	...	30	...	22
May	84	...	26	...	18
June...........	63	...	22	...	18
July	100	...	36	...	25
August	75	...	27	...	19
September	69	...	27	...	19
October	78	...	33	...	23
November ...	74	...	29	...	22
December ...	47	...	21	...	17

Again, in 1901, we find the market remarkably steady, exactly £1 per cwt. is the value of these fish "landed" at Pwllheli.

Turning to the year 1902, one finds the steadiness of price and quantity of fish is maintained until the end of April, when there is a remarkably sudden fall to zero, which is steadily maintained until the end of the year. Now, it is practically certain, that either the figures previous to or after May, 1902, are incorrect, since such a sudden change cannot be due to natural causes. From what one knows of Pwllheli and the distribution of fish in the Irish Sea and Cardigan Bay, one is forced to the conclusion that the figures previous to May, 1902, are grossly inaccurate.

PWLLHELI, 1902.

	Cod.	Hake.	Ling.
January ...	83	28	26
February ...	77	30	26
March ...	82	42	36
April... ...	72	40	33
May	—	—	—
June... ...	—	—	—
July	—	—	—
August.........	—	—	—
September ...	—	—	—
October	—	—	—
November ...	—	—	—
December ...	—	—	—

As is but to be expected, these remarkable statistics do not apply to cod, hake, and ling alone, but to all other fish landed at Pwllheli. The figures for all other kinds of fish for Pwllheli for 1902 are given in the next table. The extraordinary change in May is to be remarked. In addition to cod, hake, and ling we find a sudden disappearance of conger eels, gurnards, haddock, lemon soles and whiting, and a remarkable falling off in brill, soles, turbot, dabs, plaice, skates and rays, and all other except shell-fish.

PWLLHELI, 1902.

Weight of Fish landed in cwts. (omitting Cod, Hake, and Ling).

	Brill.	Soles.	Turbot.	Conger Eels.	Dabs.	Gurnards.	Haddock.	Herrings.	Lemon Soles.	Plaice.	Skates and Rays.	Whitings.	All other, except Shell-fish.
January	62	130	36	16	77	114	40	...	53	89	133	150	114
February ...	68	126	46	22	109	152	46	...	74	111	164	182	50
March	51	118	36	18	103	146	38	...	63	99	148	160	36
April	46	108	37	14	79	138	39	...	44	91	154	140	38
May	12	38	8	...	8	...	...	...	...	8	7	...	...
June	12	45	7	...	12	...	...	...	...	10	20	...	...
July	13	48	8	...	14	...	...	...	...	12	19	...	3
August	6	33	4	...	6	...	...	...	...	12	11	...	3
September ...	6	45	6	...	6	...	...	...	...	12	12	...	2
October	4	20	4	...	6	...	...	780	...	6	10	...	...
November ...	2	5	2	...	10	...	...	846	...	6	10	...	...
December ...	12	21	4	...	24	...	...	1299	...	32	59	...	...

The same remarkable change is seen in the case of shell-fish. Previous to May, 1902, we have no record of certain kinds of shell-fish landed at Pwllheli. In that month the record commences; but the table speaks for itself.

SHELL-FISH LANDED AT PWLLHELI, 1902.

	Number.		Other Shell-fish—Weight in cwts.			
	Crabs.	Lobsters	Cockles.	Mussels.	Prawns.	Peri-winkles.
January	...	...	...	...	...	...
February	...	...	...	...	...	...
March	...	...	...	...	...	...
April	...	...	...	...	...	...
May	2834	568	17	...	1	12
June	1826	628	11	...	2	8
July	2028	849	10	...	4	4
August	1832	604	12	...	4	...
September ...	1684	523	8	105	2	...
October	...	...	14	125	...	44
November ...	...	...	10	115	...	64
December... ...	...	...	10	98	...	48

Compare this table with 1900, 1901 on the one hand, and 1903 on the other hand. Tables given below.

SHELL-FISH LANDED AT PWLLHELI, 1900.

	Crabs.	Lobsters.	Periwinkles (cwts.)
April	1200	1600	96
May...	1200	1600	...
June	2100	2800	...
July	1500	2100	...

From January to March and August to December inclusive there are no shell-fish returned as being "landed" at Pwllheli.

PWLLHELI, 1901.

January, February, March, April, and May, nil.

June, 800 Crabs and 12,000 Lobsters.

July, 1,200 Crabs and 1,800 Lobsters.

August, September, October, November, and December, nil.

SHELL-FISH LANDED AT PWLLHELI, 1903.

	Number.		Other Shell-fish—Weight in cwts.			
	Crabs.	Lobsters	Cockles.	Mussels.	Peri-winkles.	Prawns.
January	...	...	8	65	32	...
February	...	...	4	51	28	...
March	...	...	4	25	8	...
April	1226	383	10	...	16	...
May	3018	625	18	...	24	1
June	3160	918	24	...	24	3
July	2169	910	12	...	20	4
August	1476	698	14	...	8	6
September ...	94	36	26	94	21	2
October	...	...	24	80	35	...
November ...	...	...	20	125	30	...
December... ...	...	...	12	240	22	...

These tables show that during 1900 and 1901, and up to April, 1902, no cockles, mussels, or prawns were landed at Pwllheli, and only 96 cwts. of periwinkles in April, 1900, and that during this time the number of lobsters landed always exceeded the number of crabs.

Subsequent to April, 1902, we find cockles, mussels, prawns, and periwinkles are being landed with a certain

amount of regularity at Pwllheli, and that crabs exceed in numbers the lobsters. From what one knows of the local shell-fish beds and the relative abundance of lobsters and crabs, one is again forced to the conclusion that the figures previous to May, 1902, are unreliable.

Mr. Johnstone sends me the following note on the question of the Board of Trade statistics of shell-fish taken in the (old) Lancashire Sea Fisheries District.

Statistics of Shell-Fish.

The total value of the shell-fish landed in the year 1898 is obtained from the official "Statistical Tables and Memorandum" for that year by subtracting the value of the fish landed at the Lancashire ports, exclusive of shell-fish, from the value of the fish landed at the same ports, inclusive of shell-fish, (see "Statistical Tables" for 1898, page 27). This gives us £29,475 as the value of *all* the shell-fish landed in Lancashire (and Hoylake).

But in 1895, during the inquiry into the bye-law proposing to close the Burbo Bank shrimping grounds for a certain part of the year, it was stated (and the Inspector holding the inquiry accepted the statement)* that the value of the shrimps landed in Lancashire was £50,000 per annum.† In 1898, with the assistance of the Fisheries Bailiffs, I estimated the value of cockles landed in Lancashire for that year as £13,370, and this estimate was probably under the mark. Therefore we have :—

	£
(1) Board of Trade value for *total* shell-fish, 1898	29,475
(2) Fisheries Committee's value for *shrimps and cockles alone*, 1898	63,370

Now both of these values cannot be right!

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* See Report Inspectors of Sea Fisheries (England and Wales) for 1895, page 42.

† It is not clear, however, whether this was meant to be the value of the shrimps landed, or of the *shrimping industry*. (I think this is the value of the shrimping industry.—J.T.J.)

Then mussels, periwinkles, and oysters are also landed. Oysters, it is true, are mostly "landed" in the sense that they are imported from America, and re-laid at Fleetwood and in the Menai Straits, but they are presumably included in the total value for shell-fish landed at our ports, which is given in the Board of Trade figures.* Mussels must have a very considerable value, for in some years over £2,000 worth are landed at Morecambe alone. Periwinkles may not amount to much, but they swell the total. Now, even considering the value of shrimps and cockles alone, this appears to be more than twice as great as the value given by the Board of Trade for total shell-fish—a discrepancy which it is difficult to explain.

A consideration of the following facts elicited by the late Mr. R. A. Dawson (I quote from an unpublished letter written by him), may however suggest the explanation. In 1902 there were 344 persons gathering shell-fish in the Lancashire District at nine places, the catches made by whom did not appear to have been included in the returns sent to the Board of Trade. The details are :—

Duddon Estuary	30	persons.
Barrow District	30	,,
Kent's Bank	9	,,
Grange	2	,,
Arnside to Hest Bank	30	,,
Lune Estuary	32	,,
Blackpool to St. Annes	40	,,
Banks District	90	,,
Mersey Estuary (Returns for cockles are given only for Hoylake and Liverpool)...	81	
Total	344	,,

* The value of American oysters taken from the beds at Fleetwood for 1898 was £3,576. This amount should be deducted from the Board of Trade value for total shellfish in order to arrive at an estimate of the local shell-fish.—J.T.J.

TABLE SHOWING TOTAL VALUE OF FISH (WET AND SHELL) LANDED AT VARIOUS PORTS IN THE LANCASHIRE AND WESTERN SEA FISHERIES AREA FOR FIFTEEN YEARS.

	1889	1890	1891	1892	1893	1894	1895	1896	1897	1898	1899	1900	1901	1902	1903	1904
	£	£	£	£	£	£	£	£	£	£	£	£	£	£	£	£
New Quay (Cardigan)	347	156	467	565	268	369	509	376	1,087	648	678	700	607	1,038	685	748
Aberayron and Aberystwyth ...	2,530	1,900	2,007	3,927	3,126	3,032	2,467	2,576	2,910	2,341	2,255	1,313	1,315	1,741	1,636	2,365
Borth and Aberdovey	No return.	†1,925	†1,439	†3,394	†2,900	†1,878	†1,141	†902	†1,319	‡728	558	327	216	89	185	142
Pwllheli	No return.	11,395	15,504	16,935	16,794	15,407	15,993	17,401	19,941	20,444	19,183	17,183	18,051	10,659	7,169	4,587
Carnarvon	2,872	3,013	2,949	2,662	2,508	3,434	3,451	3,990	4,375	3,525	3,379	2,769	2,841	3,081	1,694	1,468
Holyhead	2,412	1,250	2,350	2,815	1,297	1,851	2,977	3,916	3,256	5,124	3,562	3,270	3,552	3,518	4,605	4,526
*Bangor	2,326	5,028	7,530	6,430	10,149	8,533	10,353	8,446	6,873	5,317	6,810	6,007	7,599	7,198	6,529	4,793
Rhyl	950	1,077	1,059	1,557	878	707	619	504	434	362	418	305	500	314	410	311
Hoylake	20,896	25,701	18,337	16,908	18,144	17,471	11,232	9,448	9,152	10,526	11,835	13,043	11,444	7,644	7,164	5,361
Liverpool	13,363	28,774	30,144	47,210	46,058	50,832	46,149	52,771	55,276	59,292	57,190	65,970	55,360	54,657	60,117	56,165
Southport and Marshside ...	No return.	4,097	4,785	5,151	12,645	7,855	21,259	8,295	8,590	9,465	8.231	9,348	10,054	11,968	11,296	10,273
Lytham	3,101	2,185	3,048	3,088	2,920	3,115	2,791	2,083	1,955	2,534	2,653	1,725	1,884	§1,679	1,392	2,324
Fleetwood	32,490	40,213	39,020	63,151	74,973	74,069	99,189	117,819	160,788	220,767	103,091	125,064	140,436	156,521§	149,632	161,106
Cark	No return.	No return.	No return.	No return.	No return.	No return.	2,111	2,449	4,633	4,404	3,220	2,963	2,687	3,083	2,152	1,291
Ulverston	No return.	No return.	No return.	No return.	No return.	No return.	2,021	733	1,668	2,060	3,252	2,469	1,846	2,221	2,052	1,019
Morecambe	12,580	13,434	17,141	14,201	11,075	9,026	10,616	8,432	6,150	6,141	7,328	7,877	8.878	9,807	11,307	9,067
Total	93,867	140,148	145,780	187,994	203,735	197,579	232,878	240,141	288,407	353,678	233,643	260,328	267,270	275,218	268,025	265,546

* The statistics of fish landed at Beaumaris, Menai, Aber, and Llanfairfechan are also included with Bangor, except during 1889. † Includes Barmouth.
‡ Includes Barmouth for 11 months only. § Partly estimated. Lytham no returns for May, and Fleetwood no returns for August and September.

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Again, in the fishing season 1901-1902, the Board of Trade returns for Morecambe showed that 1,373 tons, 15 cwts. of mussels were landed there. But it was ascertained that, in the same fishing season, about 2,250 tons of mussels (nearly twice the quantity) were sent by rail from Morecambe. With the exception of a "few bags" landed by steamer from Londonderry, all these mussels were taken directly from the fishing grounds.

JAS. JOHNSTONE.

Having now considered the total figures—which can by no means at present be used to appraise the yield of the Irish Sea—it remains to consider the statistics in greater detail, and this may be done in one of two ways.

Either one may take a given port or combination of ports and from the totals of all fish, both wet and shell, landed arrive at an idea of the prosperity of the district as a whole; or one may take a given fish—say soles or shrimps—and from the totals for the whole district arrive at an idea of the increase or decrease of that particular fish in our district.

Neither system is unattended with difficulties, and objections obviously suggest themselves to either method; in many instances these objections have proved fatal, and in those cases the figures have been omitted. In other instances the results are such as to justify publication; at any rate, this much is certain—they are the only figures available.

Taking the prosperity of any given port first—the figures are given in the preceding Table—we find that Fleetwood and Liverpool have, on the whole, shown a steady increase—with exceptional years for Fleetwood in 1897 and 1898. These figures are expressed in a graphic manner below.

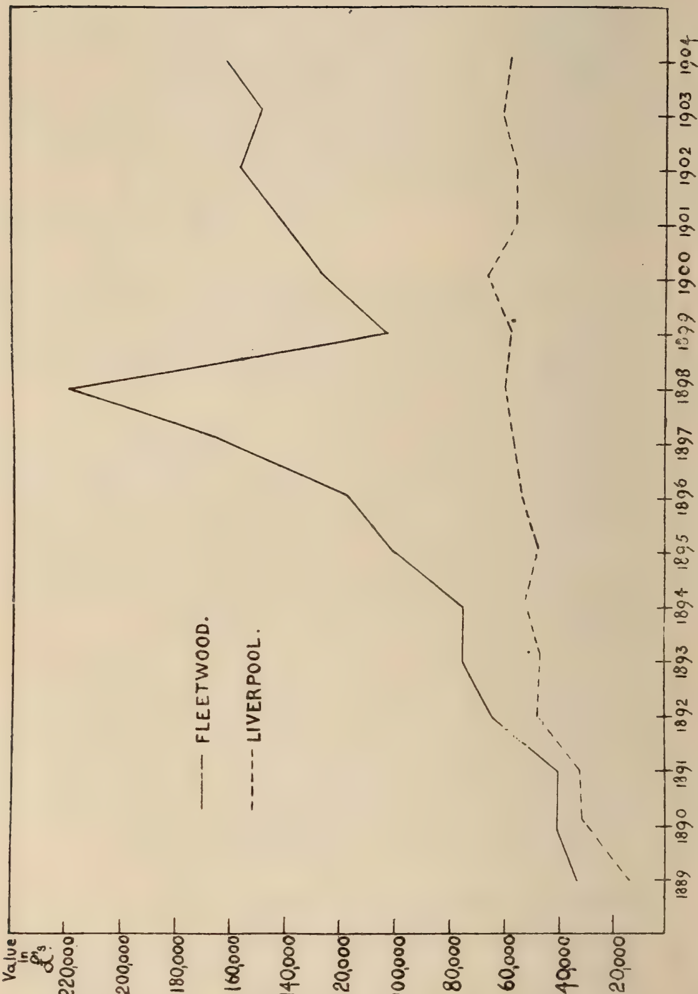


Fig. 1. Value of Wet and Shell-fish in £'s landed at Fleetwood and Liverpool during the period 1889-1904.

The figures at the base of the plate show the years, the figures at the side the value of the fish in tens of thousands of pounds. Suppose one wishes to find the value of fish landed, say, in Fleetwood in 1896, one runs one's eye along the lower line till the year 1896 is reached, then along the side line until the angle above 1896 is seen to be on a level, or nearly on a level, with the £120,000 figure. This shows that nearly £120,000 worth of fish was landed at Fleetwood in 1896.

A rise in the "curve" denotes an increase in value, a depression a decrease.

The sudden decrease in the value of fish landed at Fleetwood in the year 1899 is to be explained by the fact that early in that year the steam trawlers owned by Messrs. Beaching and Kelsall left Fleetwood to fish from ports on the East Coast.

On the whole, then, these ports have shown a steady increase, this being due to the steam trawlers, who have, of course, to a very large extent got their fish from distant fishing grounds. Of the prosperity or otherwise of the sailing craft of these two ports it is impossible to form any idea, since the figures are swamped by the far more predatory steam trawler.

We now come to two curves which show us some interesting results, and these are the curves for Southport and Marshside and what I may call for convenience the Morecambe Bay Area, comprising the "ports" of Cark, Ulverston, and Morecambe.

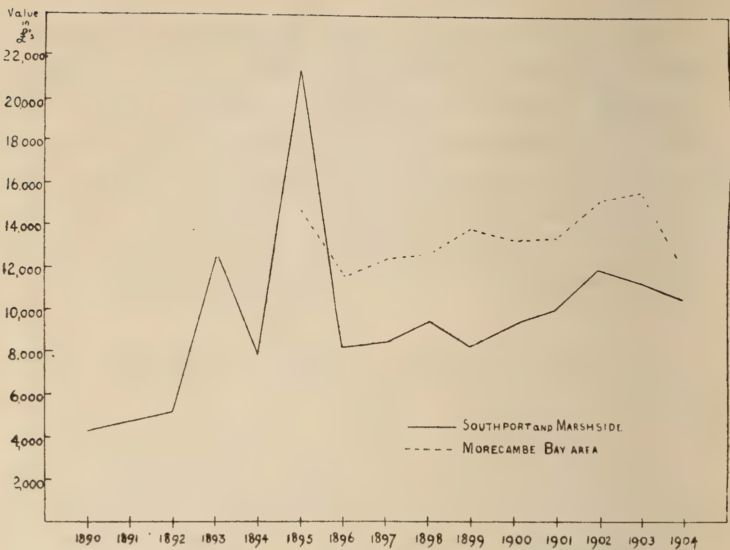


Fig. 2. Value of Wet and Shell-fish in £'s landed at Southport and Marshside, and in the Morecambe Bay area (Cark, Ulverston and Morecambe) during the period 1890-1904.

In both these districts the fish are entirely caught in or near the territorial waters, so that for the greater if not the entire portion of their life history they are protected by the Committee's bye-laws.

The number and description of the fishing boats proves this, they are entirely second or third-class boats and consequently do not fish at any great distance from the land. The shell-fish are also within the Committee's jurisdiction. Assuming that the co-efficient of error in the Board of Trade's figures is constant, one feels convinced that the Committee may legitimately be satisfied that not only have the fisheries in the two instances not retrograded, but that there is on the whole a steady and uniform increase, modified in the case of Southport and Marshside by two exceptional years, namely, 1893 and 1895.

There remains for consideration the value of the different kinds of fish landed at all the ports in the district. If the statistics had been collected for the whole Irish Sea area, to the exclusion of other fishing grounds, then we should have some idea of the relative abundance of any given species.

One striking fact revealed by a study of the returns is that hake is by far the most valuable fish, taken in the aggregate, of any landed at our ports.

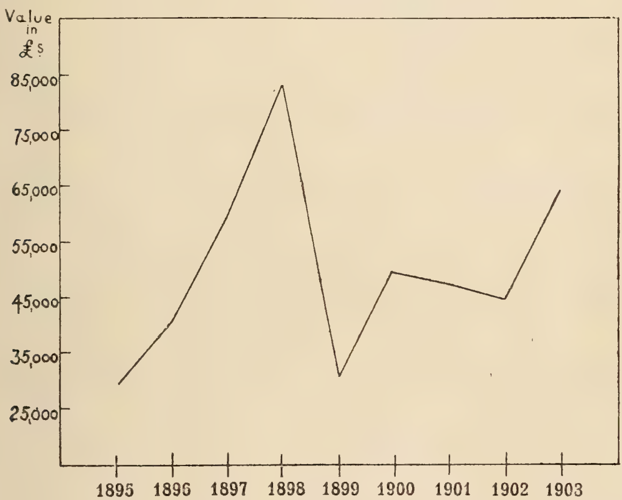


Fig. 3. Value of Hake in £'s landed in the Lancashire District during the period 1895-1903.

This fish is, according to the returns, landed at Fleetwood, Liverpool, and Pwllheli. Further inquiries revealed the fact that Pwllheli hake was not hake, whatever else it may have been.

Omitting the Pwllheli hake of doubtful odour, the figures for the other two ports are given, month by month and year by year, from 1895 to 1904 (inclusive). The tables are

interesting, as showing a fish almost exclusively taken by steam trawlers, and certainly, to a very large extent, remote from the district.

VALUE OF HAKE LANDED IN LANCASHIRE DISTRICT (RHYL TO MORECAMBE).

	1895	1896	1897	1898	1899	1900	1901	1902	1903	1904
	£	£	£	£	£	£	£	£	£	£
January	730	604	579	460	615	577	670	1,627	862	1,171
February ...	1,002	447	1,036	2,360	843	1,362	1,503	2,278	1,760	1,572
March	1,902	839	1,054	2,451	1,164	1,341	2,001	2,227	667	3,369
April	2,198	5,290	1,475	1,854	1,498	1,519	2,574	1,766	2,889	4,863
May	1,500	3,470	1,972	3,161	1,505	3,922	3,495	7,405	10,155	6,510
June	3,496	7,001	4,531	9,165	5,318	14,777	7,962	6,749	9,893	8,872
July	2,680	4,779	6,378	17,887	3,338	6,801	8,618	9,543	9,475	6,516
August	2,825	6,111	13,702	16,291	5,532	9,129	7,103	3,196	7,109	10,453
September ...	4,979	5,202	17,829	17,323	4,786	5,370	5,608	1,739	8,712	6,065
October	4,046	3,305	3,860	6,787	4,020	2,291	3,317	3,081	4,284	4,413
November ...	2,530	2,591	5,001	3,934	943	1,765	3,040	2,026	5,361	2,753
December ...	1,021	930	2,298	1,279	1,030	638	1,585	2,881	3,678	1,702
Total ...	28,909	40,569	59,715	82,952	30,592	49,492	47,476	44,518	64,845	58,259

The fact that soles are on the increase is illustrated by the next table of figures, and is also graphically represented by the curve.

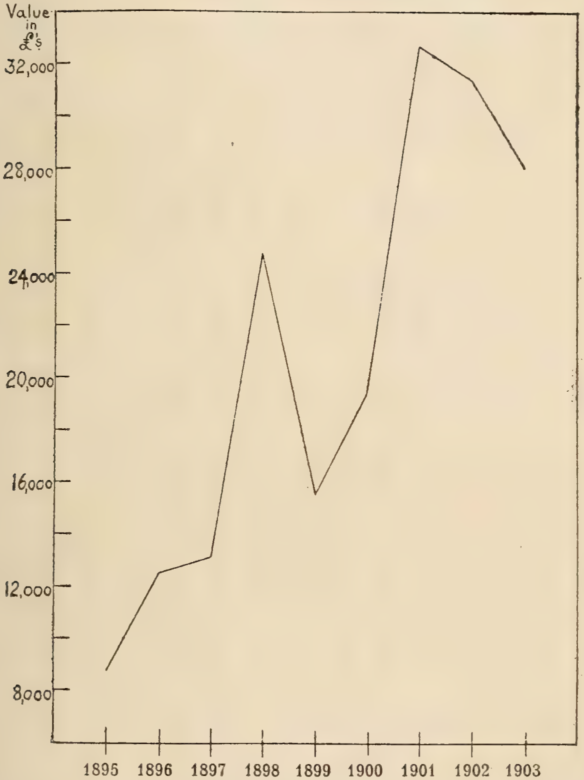


Fig. 4. Value of Soles in £'s landed in the Lancashire District during the period 1895-1903.

This fish is undoubtedly caught in large quantities by deep-sea sailing trawlers within the Irish Sea area, and there can be little doubt that for the last few years this fish has increased in the district.

The curve exhibits a remarkably steady and rapid rise with an exceptionally good year in 1898, which year it may

be remarked, corresponds with the maximum period of steam trawler activity at Fleetwood. The rise between 1900 and 1901 is even more marked than that which took place in 1898.

Value of Soles landed at the Ports of Rhyl, Hoylake, Liverpool, Southport, Lytham, Fleetwood, and Morecambe from 1895 to 1904 (both inclusive).

	1895	1896	1897	1898	1899	1900	1901	1902	1903	1904
	£	£	£	£	£	£	£	£	£	£
January	330	711	374	1,388	848	509	1,061	925	849	924
February ...	230	423	453	1,288	499	523	1,030	689	793	1,297
March	231	573	360	2,415	826	1,424	1,820	1,401	842	1,550
April	441	1,321	987	3,167	1,089	1,072	2,050	2,339	3,752	1,955
May	1,493	1,502	2,275	2,262	2,003	2,512	5,278	4,167†	4,781	4,096
June	1,003	783	658	2,043	1,154	895	1,896	3,126	3,815	2,385
July	1,347	1,557	1,177	2,981	1,780	1,886	3,934	3,293	2,003	1,753
August	499	892	1,101	1,346	1,840	2,038	3,776	3,626*	1,943	3,356
September ...	1,061	826	1,243	3,165	1,341	2,477	3,665	3,628*	3,070	1,976
October	824	1,665	1,864	1,633	1,624	2,378	3,759	4,130	2,105	1,886
November ...	843	1,767	1,532	1,680	1,398	2,119	3,205	1,669	2,003	1,734
December ...	503	558	1,106	1,467	1,122	1,626	1,306	1,488	2,143	825
Total ...	8,805	12,578	13,130	24,835	15,524	19,459	32,780	30,481	28,099	23,737

† Complete returns not to hand from Lytham. * No returns for Fleetwood, but 1901 figures taken in.

The figures for plaice cannot be regarded as satisfactory. A remarkable diminution is to be observed. Possibly some explanation may be found for this, but from only four months' acquaintance with the district it would be rash on my part to hazard an opinion.

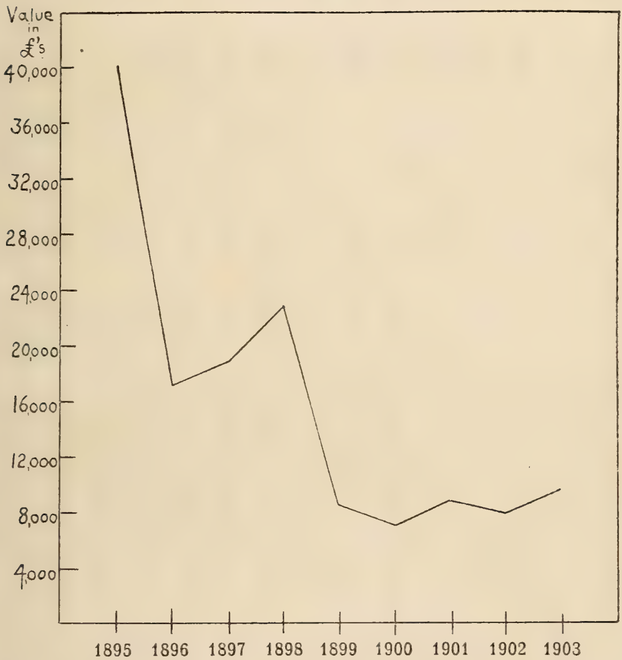


Fig 5. Value of Plaice in £'s landed in the Lancashire District during the period 1895-1903.

VALUE OF PLAICE LANDED IN LANCASHIRE DISTRICT (RHYL TO MORECAMBE—BOTH INCLUSIVE).

	1895	1896	1897	1898	1899	1900	1901	1902	1903	1904
	£	£	£	£	£	£	£	£	£	£
January	871	2,468	1,846	3,030	1,414	1,133	1,616	1,329	1,413	663
February ...	957	1,411	1,631	1,157	846	296	1,109	703	1,567	719
March	1,296	941	1,874	1,665	1,201	733	849	768	1,566	807
April	1,939	621	1,557	2,961	695	471	356	701	1,486	473
May	1,707	1,345	1,869	1,710	504	394	216	228	210	806
June	3,434	962	1,015	524	348	235	281	308	307	620
July	6,856	1,769	1,657	2,692	453	437	863	554	356	296
August	4,997	847	1 055	1,533	492	462	786	*839	578	369
September ...	4,059	1,505	850	2,145	337	569	851	*856	562	382
October	6,202	1,818	1,882	2,306	585	816	556	440	440	579
November ...	4,350	1,893	1,389	1,544	491	619	415	531	376	455
December ...	3,746	1,516	2,249	1,477	1,090	961	908	695	798	796
Total ...	40,414	17,096	18,874	22,744	8,456	7,126	8,806	7,952	9,659	6,965

* No returns for Fleetwood, but 1901 figures included.

The shrimp fishing industry certainly shows no signs of deterioration as will be gathered from reference to the following curve and figures.

Fig. 6. Value of Shrimps in £'s landed in the Lancashire District during the period 1895-1903.

The "shrimps" include two distinct species, the common shrimp (*Crangon vulgaris*) and the red shank (*Pandalus annulicornis*).

There can be no objection to including these together since they are closely allied crustacea and are both captured entirely within or closely adjacent to the territorial waters.

Value of Shrimps and Prawns Landed at Ports from Rhyl to Morecambe (being the Lancashire District as amended by Board of Trade Order of 1894) from 1895 to 1904.

	1895	1896	1897	1898	1899	*1900	1901	1902	1903	1904
	£	£	£	£	£	£	£	£	£	£
January	206	1,376	573	653	607	965	1,403	1,161	1,414	1,418
February ...	‡	1,141	352	500	658	672	1,102	1,108	1,219	584
March	293	1,101	516	530	808	768	1,201	1,363	927	1,297
April	1,470	885	743	874	1,082	1,417	2,188	1,744	1,377	1,788
May	2,054	1,553	981	1,030	1,585	1,761	2,625	2,186	2,276	2,473
June	1,253	1,498	1,044	996	1,735	1,675	2,546	1,629	2,472	2,252
July	1,603	1,322	731	741	885	1,482	2,367	1,688	2,508	2,209
August	1,819	1,024	1,086	1,053	1,215	1,346	1,908	†2,188	2,064	1,805
September ...	1,885	897	1,217	1,410	1,678	1,933	2,118	†2,243	2,604	2,048
October	2,270	2,534	1,170	1,565	2,217	2,218	2,156	2,422	2,750	1,995
November ...	2,405	1,653	663	1,254	2,071	2,120	2,000	2,407	2,358	1,472
December ...	1,719	797	520	1,130	1,079	1,709	1,106	1,742	2,040	949
Total ...	16,977	15,781	9,596	11,736	15,620	18,066	22,720	21,881	24,009	20,290

* This Table includes Cark and Ulverston from 1900 onwards, but as the figures for these two places are so small compared with the total the results are not appreciably affected. † Include Fleetwood figures for 1901.
‡ No shrimp statistics given for this month.

The Cockle Industry in Morecambe Bay.

During the last quarter my attention has frequently been drawn to statements made in "Cartmel District Weather and Farming Notes," which statements have been rather

extensively reproduced and commented on in the public press. It may be stated that the following figures relating to the number of tons of cockles and mussels sent away from Cark Station during the last 23 years are quoted, and remarks adverse to the Committee's work based thereon :—

From "Cartmel District Weather and Farming Notes," October, 1904.

SAND FISHERY.

"Number of tons of cockles and mussels sent away from Carke Station during the last 23 years :—

Year.	Tons.	Year.	Tons.
1882	2827	1894	1218
1883	2665	1895	743
1884	1177	1896	930
1885	861	1897	2011
1886	662	1898	1797
1887	1040	1899	1286
1888	1616	1900	1059
1889	2488	1901	1250
1890	3161	1902	1232
1891	2749	1903	885
1892	1684	1904 (10 months)	711
1893	1336		

"Weights in tons sent each month from November, 1903, to October, 1904, inclusive :—

	Cockles.	Mussels.	Flukes.
November, 1903 ...	$117\frac{1}{4}$ ...	$11\frac{3}{4}$ ...	$\frac{3}{4}$
December, ,, ...	$95\frac{3}{4}$ ...	$\frac{1}{2}$ ...	2
January, 1904 ...	78 ...	$16\frac{1}{4}$ ...	—
February, ,, ...	$73\frac{1}{2}$ ...	$14\frac{1}{2}$ ...	—
March, ,, ...	60 ...	6 ...	—
April, ,, ...	$55\frac{1}{2}$ ...	6 ...	—
May, ,, ...	35 ...	— ...	—
June, ,, ...	$18\frac{1}{2}$ ...	— ...	—
July, ,, ...	$3\frac{1}{4}$ ...	— ...	$\frac{1}{2}$
August, ,, ...	$15\frac{1}{2}$ ...	— ...	—

	Cockles.	Mussels.	Flukes.
September, ,, ...	26¾ ...	24¾ ...	—
October, ,, ...	41¾ ...	8½ ...	¼
	620¾ ...	90¼ ...	3½

"It has been a very bad year for cocklers—the worst of any since 1886. Mussels vary in quantity year by year even more than cockles. In 1900 there were 260½ tons; in 1901, only 93 tons; in 1902, 392 tons; in 1903, 171 tons; and in 1904, 90 tons.

"Flukes have also been very scarce. In 1900 there were 34¾ tons; in 1901, 14½ tons; in 1902, 7¾ tons; in 1903, 6¾ tons; and in 1904, 3½ tons.

"No weight of samphire was sent away in 1904, whereas in 1901, 3 tons; in 1902, 4½ tons; and in 1903, 1½ tons were sent.

"Winkles are never abundant. In 1902, 7 cwt.; in 1903, 49 cwt.; and in 1904, 13 cwt. were sent away.

"The average weight of cockles, including mussels, sent away in 10 years, from 1882 to 1891, was 1,924 tons per annum; and in the 12 years, 1892 to 1903 inclusive, only 1,287 tons per annum.

"This does not point to any good whatever having been done by the Lancashire Sea Fisheries Committee as respects the Carke sands—quite the opposite, unless we hazard the conjecture that if it had not been for them it would have been very much worse, which we doubt. Can it be that there are more seagulls and other birds which feed on cockles than there used to be, encouraged by the riddling that goes on upon the surface of the sands?"

And further, in October, 1903, we have the following:—"There have always been series of years of extremely good

gatherings and then series of years of a great falling off in quantity, as may be noticed on looking over the preceding statistics; but since the Lancashire Sea Fisheries Committee have interfered at some considerable cost to the ratepayers the quantity gathered in the best years has never reached within several hundred tons what the cocklers sometimes obtained before that Committee's interference became so active."

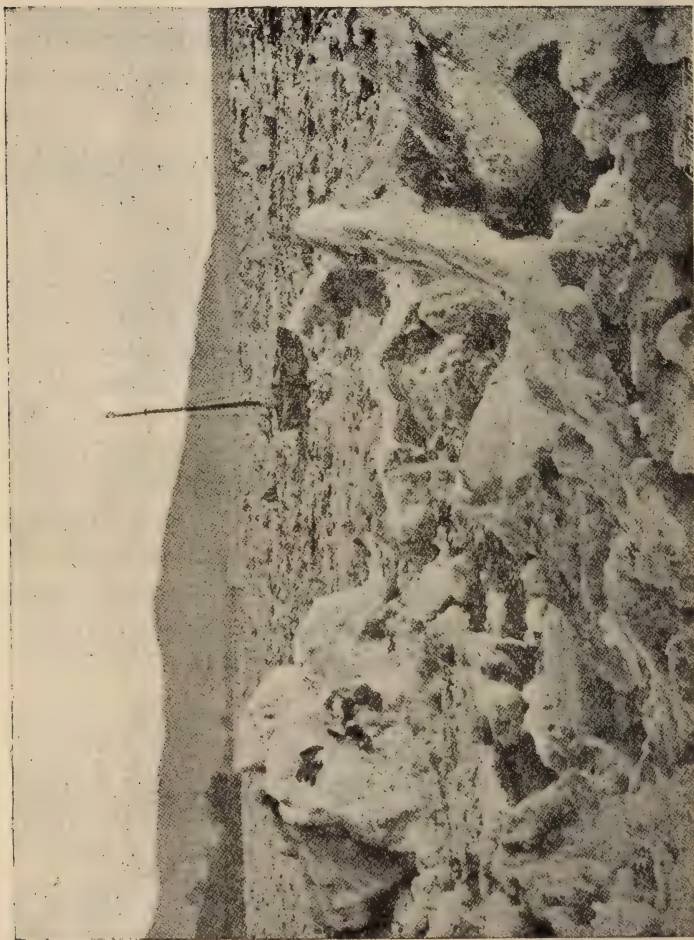
In the first place there are one or two rather misleading statements which may be dealt with before one proceeds to a detailed consideration of the whole subject.

The statement that the Lancashire Sea Fisheries Committee have interfered at some considerable cost to the ratepayers is rather apt to create a false impression, and it may therefore be as well to mention that under the Order made by the Board of Trade under the provisions of the Sea Fisheries Regulation Act of 1888 for uniting the Lancashire and Western Sea Fisheries Districts, Clause 21 (6), states that none of the said Counties or County Boroughs (constituting the district) shall be chargeable in any financial year with a sum greater than the amount which can in that year be raised by a rate of one-sixteenth of a penny in the pound on the rateable value of the property within such County or County Borough.

The above criticism also states that the average for 10 years, from 1882 to 1891, was 1,924 tons per annum; and in the 12 years, 1892 to 1903 inclusive, only 1,287 tons per annum. Nothing is said of the climatic conditions which have influenced the fisheries during the two periods.

At an Inquiry held by Mr. John Fell at Flookburgh on February 29th, 1896, the fishermen stated that in the winter of 1894 and 1895 the bulk of the larger cockles had been killed by the severe frost. A striking photograph of the state of the cockle beds was published by the "Pall Mall Magazine" for

September, 1898, on p. 134. This photograph is here reproduced, thanks to the courtesy of the Editor of the "Pall Mall Magazine."



THE COCKLERS' FOE," 1895.

The writer of the article in the "Pall Mall Magazine" says:—"The cocklers' foe, the awful frost of 1895, when the Bay presented a perfectly Arctic appearance, killed the cockles

by tens of thousands, and the cocklers, in order to make up the necessary weight, took to gathering the small, half-grown cockles, which process would, if permitted, exterminate the fish altogether."

And yet these years, with their abnormally low totals, are included in a series of years the low average of which is directly attributed to the Lancashire Sea Fisheries Committee.

It is now necessary to give in some detail the history of these beds, of the various inquiries which have been held regarding them, and of the bye-laws which have been passed for their protection. On the 8th May, 1878, an inquiry was held at the Temperance Hall, Ulverston, by Messrs. Frank Buckland and Spencer Walpole.* It was ascertained that no less than 2,253 tons of cockles, worth £11,000, were sent away in 1877 from the stations on the north side of Morecambe Bay. "In addition, it is estimated that one-third of the entire take is consumed in the neighbourhood. The cockles, therefore, taken every year on the north side of Morecambe Bay alone must weigh over 3,000 tons and be worth over £16,000. We believe that we are within the mark in saying that the cockles from the south side of the bay are worth more than £5,000 a year. It follows, therefore, that the value of this little mollusc to the Morecambe Bay fishermen cannot be less than £20,000 annually. Yet, from inquiries which we have made in Morecambe Bay, we are unable to trace any decrease in the yield of this fishery."

At the above-mentioned Ulverston inquiry, the fishermen who gave evidence were of opinion that the gulls killed a great many cockles. One fisherman said that the sea-gulls have

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* Report by Frank Buckland Esq., and Spencer Walpole, Esq., Inspectors of Fisheries for England and Wales and Commissioners for Sea Fisheries on the Sea Fisheries of England and Wales. Eyre & Spottiswoode, 1879.

doubled in number since the Sea Birds Act came into operation. At Furness, on the 9th May, the fishermen also complained of the gulls, and stated in addition that the cockle industry was falling off. Though some of the statements are obviously exaggerated, it is nevertheless credible that the cockle industry may have begun to fall off ten years before the passing of the "Sea Fisheries Regulation Act of 1888." At the Furness inquiry a letter from Mr. William Wanklyn (written to Mr. John Fell) was handed in, advocating a close time for cockles on account of the decrease in supply. In the same letter a gauge for cockles and mussels was advocated. Mr. Frank Buckland, in Appendix No. II. to this Report states "Some check ought to be put on these sea-gulls" (bottom of page 214).

The next inquiry, held at Ulverston, was in November, 1889, when the Lancashire Sea Fisheries Committee was being instituted.* This was a period when a large quantity of cockles were being sent away from Cark (*vide* fig. 7). Mr. Fell at the opening of this inquiry said:—"There are no regulations in force at present, and we have come to you to get you to provide us with actually correct information as to the state of the fishing interests in this estuary, in order that we may draw up regulations which will generally help the fishermen. It will be in the public interest, in so far as these regulations should increase the supply of fish, and we come to ask you for the information necessary to prepare these regulations." Extracts relating to cockles are appended. The Rev. Mr. Rigge said:—"With regard to cockle fishing, there is a strong desire felt by the fishermen in Flookburgh that the 'jumbo' should be discontinued; it is very injurious to the fisheries, and they are very desirous that there should be no

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*The County Council of the County Palatine of Lancaster. Evidence taken at the inquiries held by the Sea Fisheries Committee of the County Council. Preston, 1890. Printed by Parkinson & Co. See especially pp. 73-99.

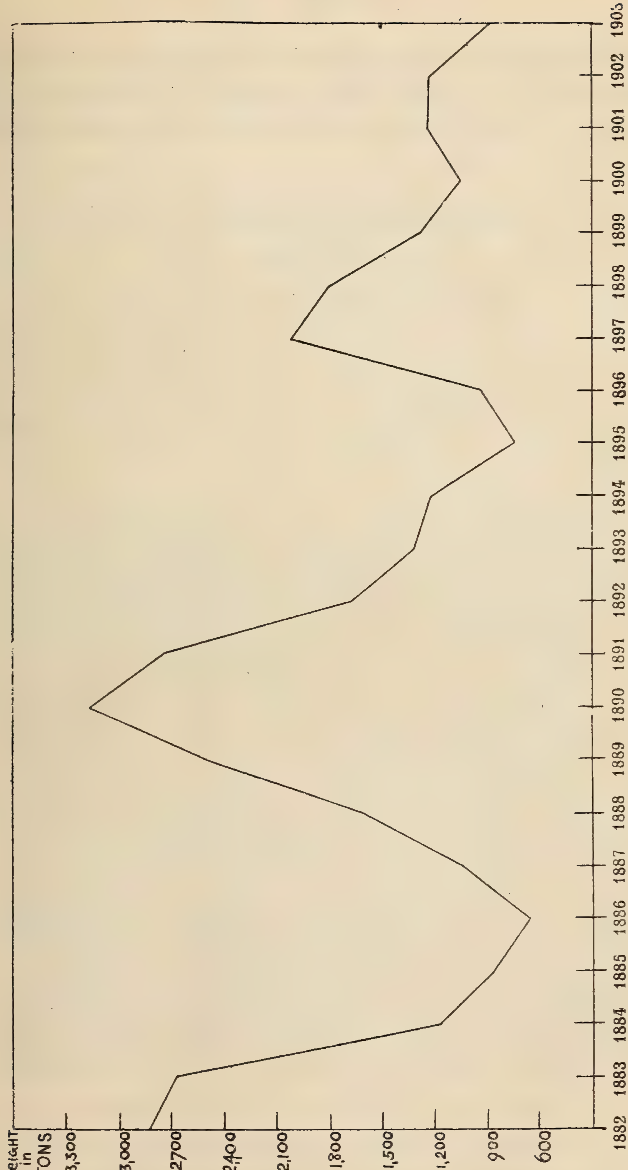


Fig. 7. Weight in tons of Cockles and Mussels sent away from Cark station during the period 1882-1903.

'jumbo' fishing for the future, either long or short; but the cockies should be got in the old way by using the small 'craam.' I think that would be very advantageous to the fishermen if adopted."

The following fishermen gave evidence *re* cockling :—

Bowskill's evidence: Had known sands a long time. Made a fair living with cockle craam. Used a ¾in. riddle. Cockles smaller than they used to be. Boards (presumably the "jumbo") first used five or six years since (1883 or 1884). A good deal of small fish broken in using the "jumbo" The price of cockles was better than it is now. I think the boards have done it.

Moore had fished for 60 years. Had got cockles 12 to the quart; now it takes a thousand. This state of affairs, brought about by the "jumbos." They want stopping altogether; it's most destructive thing ever made. What they "mash" and do one way and another, they never give cockles time to grow. They are destroyed before they ever reach a quarter of their proper size. A seven-eighths riddle and make 'm riddle 'm I should advise you to stop those "jumbos" and drags.

John Hall, of Silverdale, thought the "jumbos" ought to be done away with.

The fishermen at Southport, Lytham, and Morecambe also expressed themselves adversely to the "jumbo" at an inquiry held at the same time at those places. The fishermen were of opinion that a seven-eighths riddle would be suitable for cockles.

The original Bye-law relating to cockles was: "No person shall fish for, take, or attempt to take cockles, except by hand, or with a rake of the following dimensions:—Not exceeding 12 inches in width, and framed with teeth not less than three-

quarters of an inch apart." (*Vide* Report of meeting of Joint Committee, February 16th, 1891.) From this it will be seen that the use of the "jumbo" was entirely prohibited.

TYPICAL COCKLERS WITH THE "JUMBO" SHOWN ON THE RIGHT.

(By permission of the Editor of the "Pall Mall Magazine.")

On the 14th September, 1892, another inquiry was held at Ulverston by Mr. John Fell as to the working of the bye-laws passed as a result of the previous inquiry. The majority of the fishermen were in favour of the "jumbo"—some for certain portions of the year, others for the whole year. It will be noted that at this time the yield of cockles was on the decrease. At this inquiry the fishermen themselves selected the seven-eighths inch cockle as the minimum size which should be saleable. At St. Annes, on 23rd September, 1892, the fishermen also expressed a wish to have the "jumbo" for three or four months in the year. At Southport the fishermen still did not desire the "jumbo." As a result of these meetings we find the limited use of the "jumbo" advocated by the sub-committee appointed to hôld the inquiries; they also advocated a craam with not more than three teeth. In February, 1893, a petition, signed by 49 Flookburgh fishermen, was sent to the Committee, stating that if the "jumbo" were to be re-introduced a three-foot "jumbo" is large enough to supply the markets.

On the 22nd June, 1893, the Board of Trade Inspector (Mr. C. E. Fryer) held an inquiry at Preston with respect to certain objections made to several bye-laws which the Lancashire Sea Fisheries Committee had submitted to the Board of Trade for confirmation. Amongst these bye-laws was one relating to cockles:—

> "No person shall fish for cockles except in accordance with the following regulations:—
>
> * * * * * *
>
> "(*c*) From the first day of November in one year to the last day of February in the succeeding year it shall be lawful to use an instrument locally known as the 'jumbo,' which shall not exceed the following dimensions: length, four feet six inches; width, fourteen inches; thickness, one inch. Provided that such instrument

> be constructed entirely of wood, and be not dragged across the cockle bed or be artificially weighted."

The only objection to this was contained in a written representation from Bolton-le-Sands, in which it was asked that the use of the "jumbo" might be permitted two months earlier than date fixed. No evidence was offered at the inquiry in support of this proposal, and the Board of Trade Inspector saw no reason for complying with it. It will, therefore, be seen that the Committee have at all times been anxious to meet the fishermen or their representatives, and have, if anything, erred on the side of leniency in making these bye-laws.

The bye-law of 1893 is that in force to-day, and it is, therefore, possible now to fish at any time of the year for cockles with hand, craam, rake, or spade, and from November to February (inclusive) with a "jumbo" of certain dimensions; provided that no cockle less than $\frac{13}{16}$ths of an inch be removed from a fishery.

The fixing of a size, below which shell-fish might not be landed was made possible by the passing of the "Sea Fisheries (Shell-fish) Regulation Act of 1894," according to which Act—

> "The powers of a local fisheries Committee to make bye-laws in pursuance of section two of the "Sea Fisheries Regulation Act of 1888" shall extend to making bye-laws to be observed within their district for the regulation, protection, and development of fisheries for all or any specified kinds of shell-fish, and any such bye-laws may provide, amongst other things, for—
>
> (*a*) The fixing of the size and condition at which shell-fish may not be removed from a fishery, and the mode of determining such sizes."

On the 26th November, 1894, the Joint Committee recommended the following bye-law be adopted :—

> "That no person shall remove from a fishery any cockle which will pass through a square aperture measuring seven-eighths of an inch on each side of the square, or three and a half inches measured round the four sides."

With regard to the curve showing the weight in tons of cockles and mussels sent away from Cark station, it may be remarked that the bulk of the material undoubtedly consists of cockles.

It will be noted that the beds rapidly deteriorate in productivity, notably from 1883 to 1886, and again from 1890 to 1895, but they are evidently capable of rapid recovery, as was the case between 1886 and 1890. The rapid fall from 1883 to 1886, and the still greater increase from 1886 to 1890, must be due to natural causes, since the Lancashire Sea Fisheries Committee did not come into existence until 1890. In Mr. Dawson's Report for January, 1902, we find the following statement regarding cockles and mussels.

"Unfortunately, a number of fishermen will persist in gathering the fish from those beds where they are most plentiful, irrespective of size, and this floods the market with small fish. It is more particularly at the northern side of Morecambe Bay that this is done, and the men in that district, I am sorry to find, take no care whatever to preserve the beds."

While part of the rapid decline in productivity may be attributed to the carelessness of the fishermen, part must also be attributed to natural causes over which we have no control. Reference has been made to this (above) in speaking of the winters of 1894 and 1895.

One hopeful sign is the rapid recovery that these beds are capable of making, and this is also exemplified by the case of

Taylor's Bank (between Formby and Crosby Channels in the Mersey Estuary) where cockles made their first appearance about five years ago, and these cockles grew in about two years to a marketable size; the fishermen, however, rapidly fished them out of existence. Subsequently another small bed formed, the last cockles from which were taken last year. It would appear then that the present depression in Morecambe Bay must not be regarded as permanent. As to the measures that might be taken to expedite their return to a maximum of productivity, a few suggestions are made below.

It would appear that some reason or reasons must be found for the persistent complaints received from the North Lancashire cockle beds. From a personal visit to these beds one is forced to agree with statements made in previous reports as to the destructive action of the gulls, taken into conjunction with the use of the "jumbo." The "jumbo" brings up to the surface all manner of cockles—marketable and undersized. The latter are left on the surface of the sand, only to be devoured by the gulls, which frequent the northern sands in enormous numbers. The excreta of these gulls is noticeably composed to a very large extent of comminuted fragments of cockle shells. I am endeavouring to get specimens of the common grey gull in order to examine the contents of the crop and stomach. The close time for gulls (except the black-backed gull) is under the Wild Birds Protection Acts, 1880 to 1902, from the 2nd March to the 31st July, both inclusive; but, on the application of Local Authorities, the Secretary of State in England and Wales has power to vary or abolish the close time for any bird or birds in any county by Order, to be published in the *Gazette*.

The breeding places of gulls on the Lancashire coast are shown on the accompanying chart.

In the Southern Districts, where the "jumbo" is unknown and gulls are not so common, we do not hear of these complaints.

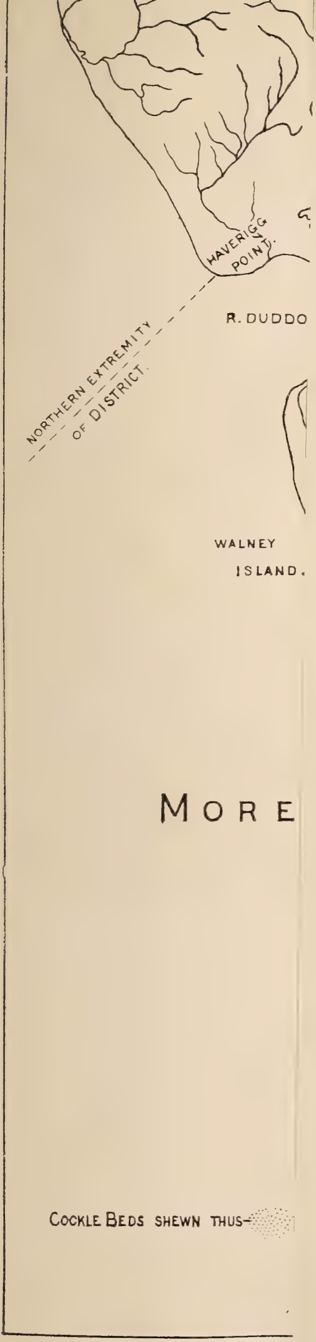
I am informed that the Wild Birds Protection Act was extended in the case of Lancashire to gulls in September, 1898.

Mr. J. R. Charnley, F.Z.S., has furnished me with the following information relating to the gulls of the district:—

> "With regard to Lancashire gulls, the herring gull is common in flocks, particularly about Walney. It is not known to breed in the county; it feeds largely on shell-fish.
>
> "The lesser black-backed gull is also common. The great black-backed gull is much less common than the last species, but is usually fairly abundant in winter.
>
> "The gulls of Lancashire are most abundant in the Morecambe Bay area. The black-headed is the only species which breeds in the county, but it is believed that a few of the herring and lesser black-backed nest on the borders of Lancashire and Westmoreland."

Mr. Charnley was also kind enough to mark on the accompanying chart the nesting places of gulls.

Finally, the present brief report on the cockle beds of Morecambe Bay area must not be regarded as conclusive. It would appear that the cockling industry would be benefited if action were taken along the following lines:—(*a*) Co-operation among the fishermen themselves to restrict the output and to obtain a better price for their fish. Sale by commission to be abolished. (*b*) Steps might be taken to exempt all species of gulls from the provision of the Wild Birds Protection Act. (*c*) Reduction of the use of the "jumbo" to a minimum.



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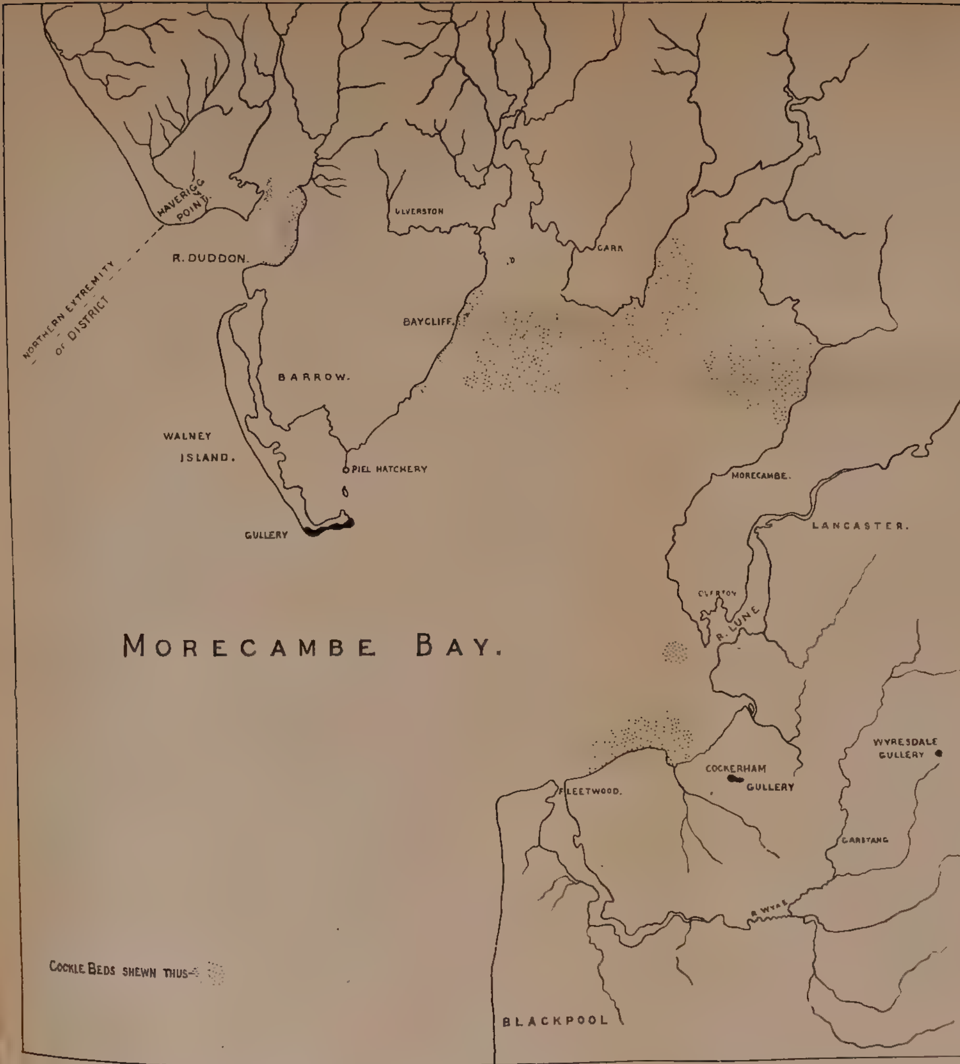

MORECAMBE BAY, shewing present positions of the Cockle-bearing sands (dotted), and of the Gulleries (black).